

APPENDIX A

WCC GROUNDWATER REMEDIAL FACILITY INTERIM REMEDIAL DESIGN



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
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Philadelphia, Pennsylvania 19107

RECEIVED

JAN 10 1992

EOT MANAGEMENT

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JAN 09 1992

Design Engineer's Report, Foster Wheeler Site,
Mountaintop, Pa.

Rich
Dear Mr. Docherty:

EPA has completed it's review of the Design Engineer's Report for the Groundwater Remediation Project at the above referenced Site. EPA hereby approves of the Design Engineer's Report provided that air monitoring of emissions exiting the two shallow tray air strippers is performed on a daily scheduled basis. Foster Wheeler needs to submit to EPA a realistic and expeditious schedule for the implementation of the tasks outlined in the Design Engineer's Report. If you have any questions please contact me at the telephone number above.

Sincerely,

Christopher P. Thomas
On-Scene Coordinator

CC: Bob FRIEDMAN
Roger HENNING
MIKE McGILL

**DESIGN ENGINEER'S REPORT
FOR FOSTER WHEELER ENERGY CORPORATION
GROUNDWATER REMEDIAL FACILITY
INTERIM REMEDIAL DESIGN
CRESTWOOD INDUSTRIAL PARK
MOUNTAINTOP, PENNSYLVANIA**

Prepared for:

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**OCTOBER, 1991
90C4170-R1**

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1.1 SCOPE OF PROJECT

The scope of this project is to design and operate an Interim Remedial Measure (IRM) with the following goals:

- (i) to remove contaminant from the groundwater and to treat the contaminant,
- (ii) to demonstrate the effectiveness of the air stripping technology, and
- (iii) to control and stabilize the contamination downgradient of the source area and near the site boundary.

This design engineer's report describes the project plans for this IRM in accordance with the guidelines set forth by the Pennsylvania Department of Environmental Resources (DER) in the "Guidelines for the Preparation of the Design Engineer's Report".

1.2 SITE HISTORY

Foster Wheeler Energy Corporation (FWEC) is the former owner of a decommissioned plant in Mountaintop, Pennsylvania; the plant location is shown in Figure 1. The plant operated from 1953 to 1984, fabricating large pressure vessels. Investigations conducted between 1985 and 1987 led to the identification of a plume of trichloroethene (TCE) contaminated groundwater originating from the area of well MW-4 and flowing generally to the southwest (see Figure 4).

During plant operation, a TCE vapor degreaser had been located near the main plant building. The degreaser was used to remove lubricants or cutting oils from machined parts. The size of the sealed degreaser tank was 12 cubic ft. During operation the tank held 12 inches of TCE at the bottom. During plant shutdown activity in 1984 and 1985, the vapor degreaser was decommissioned, pumped of its contents, and removed. Results

of soil and groundwater sampling indicate that the immediate area around the former vapor degreaser operation exhibits the highest level of TCE contamination.

A Consent Agreement and Order (CAO) was executed on behalf of both the United States Environmental Protection Agency (USEPA) and the Pennsylvania Department of Environmental Resources (DER) on one hand, and FWEC on the other. The CAO became effective February 29, 1988.

Under the CAO, FWEC was required to submit a Site Investigation Program (SIP) that included a hydrogeologic investigation to assess the horizontal and vertical distribution of contaminants and to provide the data necessary to evaluate groundwater pumping and treating alternatives. Also, pursuant to the terms of the CAO, FWEC has the right to request that the EPA and DER review and approve interim remedial measures (IRMs). In addition to its other purposes, the use of the IRMs at the Mountaintop site will enable an evaluation of the groundwater pump and treat remediation modality.

The IRMs are an interim measure for the remediation of the aquifer and should not be considered as the final design. However, the IRMs will serve as a basis for the final design. The final design most likely will be an expansion of the IRM groundwater recovery system with the addition of groundwater recovery wells at other strategic locations to capture the flow of the contaminated groundwater.

Morrison-Knudsen Company, Inc. (MK) purchased the facility from FWEC on August 22, 1989. FWEC has retained the responsibility to comply with the CAO.

1.3 SITE GEOLOGY

Mountaintop is located in Luzerne County, PA. The site is underlain by bedrock of the Upper Devonian age Duncannon Member of the Catskill Formation (Glaeser, 1974; Newport, 1977). The Duncannon Member is characterized by red conglomerates, sandstones, siltstones, and shales believed to be deposited in a meandering stream paleoenvironment (Glaeser, 1974). Overlying the Catskill Formation are unconsolidated glacial deposits of Pleistocene age. The glacial deposits consist of a mixture of clay, silt,

sand, and gravel; these deposits were found to be up to 20 feet thick at the site (WCC, 1986).

1.4 HYDROGEOLOGY

Water level contour maps from the Phase II investigation report (WCC, 1987) and water level elevation data collected from January 1987 to November 1989 have provided background information on water table conditions. Depth to ground water beneath the site ranges from 10 to 58 feet below the ground surface and fluctuates in some wells as much as 35 feet in a year. Ground water occurs in both the primary and secondary openings of the Catskill Formation. However, ground water movement may be restricted to interconnected joints and fractures (secondary openings). Water table elevation contour maps of the site indicate that the direction of ground water flow generally is to the south with an average hydraulic gradient of 0.02 ft/ft.

At the site, the Duncannon Member of the Catskill Formation is an unconfined water table aquifer. Recharge of the aquifer is received by the infiltration of precipitation through the overlying glacial deposits. CH2M-Hill (1990) reported a perched water zone along the east side of the intermittent stream. Recharge of the aquifer at the southeast corner of the site is contributed to by leakage from this perched zone.

Due to its large areal extent, the Catskill Formation provides more groundwater-based water supplies than any other formation in the county. Wells drilled in the formation usually range in depth from 24 to 580 ft below grade and range in yield from 2 to 325 gpm. Median yield of these wells is 12 gpm, and if yields greater than 25 gpm are desired, a depth exceeding 200 ft is usually necessary (Newport, 1977).

The Catskill Formation is considered a reliable source of water at small to moderate yields (Newport, 1977). For domestic purposes, wells drilled to a 40 to 50 ft depth range should yield sufficient water. Wells for municipal and industrial uses are more difficult to obtain and test wells may be required in order to locate a productive well properly (Newport, 1977).

GENERAL INFORMATION

2.1 GENERAL PROJECT DESCRIPTION AND FACILITY STATUS

The groundwater recovery and treatment system includes the installation of three (3) recovery wells and pumping systems, below ground conveyance piping, shallow tray air stripper system, concrete settling pit, well level data logger, and a metal-sided process building. Since the service life of the interim remediation effort is indefinite, this installation is considered permanent and will be designed to meet those expectations.

The air exhaust from the stripper will be released into the atmosphere without further treatment and the stripped groundwater stream will flow through the settling pit and be directly discharged into the nearby creek bed.

No raw materials will be required for this process and no products will be manufactured. No process water will be required to operate the facility. The recovery well water flowrate to the treatment system will range from 20 - 165 gpm with a TCE concentration ranging from 1-20 ppm. The maximum TCE concentration will be controlled at 20 ppm by blending of well waters. To establish a design basis for the air stripper, the recovery well water has been characterized as follows:

Design Flow Rate: 20 - 165 gpm

Influent Quality:
(Design Basis)

Trichloroethylene:	20 ppm
Iron:	10 ppm
Chloride:	20 ppm
Hardness:	50 ppm
Bicarbonate	50 ppm

Service:

Continuous Duty - 24 hours/day, 7 days/week

The design basis for the air strippers will be the removal of TCE to a level of 5 ppb. Preliminary inquiries have been sent out to vendors and following a review of the packages returned, a North East Environmental Products, Inc Shallow Tray Aeration System Model 31231 has been selected. A copy of this vendor quote can be found in Appendix A-4.

2.2 GENERAL FACILITY LAYOUT DIAGRAM

The Site Plan is detailed on Drawing No. 01-02-001 and the Treatment Building layout is developed on Drawing No. 01-05-001. Both of these drawings in addition to the rest of the engineering drawing package is contained in Appendix B. The Site Plan shows the location of the proposed new Treatment Building with connections to the three recovery wells by buried piping and conduit routings. The equipment is located relative to the existing road, creek, and railroad tracks. The Treatment Building General Arrangement Drawing shows the proposed layout of the strippers, settling pit, control area and personnel facilities. The building is designed for winter operation and maintenance access to the Shallow Tray air strippers.

2.3 GENERAL SCHEMATIC WATER/WASTEWATER FLOW DIAGRAM

Figure 2, which is a General Schematic Water/Wastewater Flow Diagram for the process, also includes the treatment facility size, capacity, and dimensions. Groundwater is extracted from RW-1 near the point of the contamination source with additional groundwater extracted downgradient using RW-2 and RW-3, both near the property border. Each well is metered separately. The water from these wells will be mixed and blended and valved to either of the 2 strippers to control the influent TCE concentration. The effluent from both strippers flows to a winterized outdoors settling sump where iron and hardness solids will be allowed to settle. The effluent wastewater from the settling sump discharges to the surface waters in a nearby creek bed on site property.

The air strippers vent through air mist eliminators to the atmosphere.

2.4 TREATMENT FACILITY SIZE, CAPACITY AND DIMENSION DIAGRAM

Figure 2 summarizes the Treatment facility size, capacity and dimensions. The design of the 3 recovery wells is summarized below.

Well No.	T.D. Feet	Screen Interval Feet	Pump Bottom Feet	Well Pumps		
				Min gpm	Max gpm	
RW-1	125	60 - 120	120	10	50	
RW-2	105	40 - 100	100	10	40	
RW-3	105	40 - 100	100	25	75	

The well depths range from 105' deep for RW-2 and RW-3 to 125 feet deep for RW-1 with flow rates of up to 40 gpm, 75 gpm and 50 gpm, respectively. At design capacity, 165 gpm of groundwater will be extracted with the flow being split between the two air strippers, each with a flow capacity of 120 gpm. The air strippers, which are 8 feet high, 13 feet long and 7 feet wide are designed for installation in an insulated and heated building which is 20 feet wide and 30 feet long. The roof on this building is peaked in the center and the height of the sidewalls will be 9 feet to allow for maintenance of the air strippers.

The settling sump receives up to 165 gpm from the air strippers and has overall dimensions of 10 feet long, 6 feet wide, and 6 feet deep. A weir divides the settling sump into a settling basin and an outfall basin. The outfall basin section is 2 feet long, 6 feet wide and 3 1/2 feet deep. The settling basin has a volume of 2,150 gallons and the outfall basin has a volume of 300 gallons.

The air from the stripper is discharged through a Koch style 4310, 304 SS, 4 inch thick by 24 inch square mist eliminator. Based on design calculations, maximum daily TCE emissions to the atmosphere from each stripper will be 20 lbs/day or 0.825 lbs/hr at 165 gpm capacity operation (Figure 2 and Figure 3).

DETAILED DESCRIPTION OF PROPOSED WASTEWATER TREATMENT PROCESS

3.1 GROUNDWATER RECOVERY WELLS - DESIGN BASIS

3.1.1 Well Pumps

The recovery well pumps will be conventional, submersible multi-stage water-well type pumps as provided by Grundfos or equal. The pumps will be electric motor driven 460 VAC. The pumps will be located with the pump bottom five (5) feet off the bottom of the well at the bottom of the screen interval. A Grundfos Model 40S 5 HP with rated capacities of 40 and 50 GPM, respectively, have been specified for RW-1 and RW-2. A Grundfos Model 60S 5 HP with a rated capacity of 75 GPM has been specified for RW-3. The final well pumps will be designed during detailed engineering.

At all times, the pump shall have a minimum of three feet of water above the pump discharge to assure adequate suction conditions.

Each pump will be sized to pump in the ranges as shown in Section 2.4. Flow rate adjustments will be made by a manual throttling valve (globe) located downstream of the flow meter in the treatment building and by cycling the pumps on and off.

3.1.2 Wellhead Design

The wellhead and local discharge piping will be installed in below grade enclosures. Freeze protection will be incorporated using self-regulating electrical heat tracing and insulation. No valving or instrumentation will be located locally in the wellhead enclosure due to its inaccessibility and the freeze problem.

3.1.3 Instrumentation and Control System

The instrumentation and control system will be developed around the Geomation 2300 and 2370 series remote measurement and control units (MCUs). These MCUs are programmed individually and will be linked together to form a network of independent control and data acquisition sites which will be accessible through a computer equipped with a modem for remote communication. The well sites will communicate with the network via radio or wire dependent on distance.

The instrumentation will feed each local MCU to allow for the control and data acquisition functions.

Automatic notification (AutoDialer) will be performed by either the PC located on site (reference Sections 4.3 and 4.5) or by equipment supplied by a local security firm.

Parameters associated with the instrumentation and control system include:

INPUTS

ANALOG

LT 101
LT 201
LT 301
FT104
FT 204
FT304
PIT701*
PIT801*
FIT-900

*part of blower package

DIGITAL

HS-100
HS-200
HS-300
LSLL-101
LSLL-201
LSLL-301
LSH 702*
LSH 802*
LSH 1000

SYSTEM GENERATED PARAMETERS AND OUTPUTS

LSL, LSH, LSHH-101

LSL, LSH, LSHH-201

LSL, LSH, LSHH-301

FQI 104

FQI 204

FQI 304

LC-702

PS-701

LC-802

PS-801

LC-1000

SYSTEM INTERLOCKS

Well Pump Interlocks (typical for all wells):

For normal operation, the pumps will cycle between the LSH and LSL levels, with the LSH level causing the pump to start and the LSL level stopping the pump. If the pump is not functioning well enough to lower or maintain the well level and the water rises to the LSHH level, an alarm condition will cause the auto dialer to notify the monitoring firm. In addition to the LSL, there is a separate switch (LSLL) in each well that supplies an independent pump shutdown signal should the LSL fail to stop the pump.

Pump shutdown will also occur due to a building sump high level signal or a stripper air blower shutdown signal.

Air Stripper Blower Interlocks:

The air stripper should run continuously for normal operation. Should the water level in either air stripper reach high level, resulting in a shutdown of its blower, and well pumps will be shutdown and an alarm signal will be sent to the monitoring firm. In

addition, a high or low pressure signal on the outlet of a blower will also cause both a blower and total system shutdown.

Building Sump Level Interlock:

The sump alarm will cause a total system shutdown; all well pumps and air stripper blowers will stop. An alarm signal will be sent to the monitoring firm.

3.1.4 Well Instrumentation

Each well will be equipped with a level element (LE) set 5 feet above the pump bottom and a level transmitter (LT) which will be tied into the data acquisition and process control system. Each well will also have a level switch low low (LSLL) probe which will be set 8 feet above the bottom of the pump. The well pumps will operate based on high and low well level software switches based on the level transmitter. If the water level in the well ever reaches the level switch low low probe, the well pump will shut off. The air-stripper blowers must be running in order for the well pumps to run.

3.1.5 Flow Measurement

Pumping rates will be measured from each well using a turbine flow meter (Badger or equivalent) with both instantaneous and totalizing local readouts. The meters will also be wired into the data acquisition and process control system. These three flow meters will be located in the treatment building just upstream of the manifolds that feed the tray strippers.

3.1.6 Conveyance Piping

Conveyance pipe will be 2, 3 and 4 inch diameter high density polyethylene (HDPE). See Appendix A-2 for Technical Specifications. The underground piping will be buried with a minimum of 4 feet of cover. The power and control wiring for the well pumps will be in the same trench as the pipe. The piping is sized to accommodate a somewhat larger flow rate than indicated in Section 2.4 for future expansion and to minimize pressure

drop. The piping will be entirely buried and will therefore enter the treatment building through the floor slab and the well head enclosure through the sidewall.

3.1.7 Treatment Works Building Piping

Piping within the treatment building will be Schedule 80 PVC in sizes under 2 inch and Schedule 40 PVC for sizes 2 inch and above. Appendix A contains complete piping material specifications for all services on this project.

Air stripper duct work, both inlet and outlet, will be heavy duty industrial grade, fabricated of material with suitable corrosion resistance for this service. Likely material of construction is either Fiberglass reinforced plastic (FRP) or Type 304L stainless steel.

3.2 AIR STRIPPERS - DESIGN BASIS

The groundwater treatment system is designed with two shallow tray air strippers manufactured by North East Environmental Products, Inc. Each stripper is designed based on the following influent and effluent properties.

Influent Water Quality:

Trichloroethylene (TCE)	20 ppm
Iron	10 ppm
Chloride	20 ppm
Hardness	50 ppm
Bicarbonate	50 ppm

Flow Rate: 20-120 gpm

Service: continuous duty - 24 hours/day, 7 days/week

Water Effluent Quality:

TCE	5 ppb
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Air Effluent Quality:

TCE

20 lbs/day

The selection of the tray stripper over the more conventional packed tower is based on the following tray stripper features:

1. competitive capital cost
2. ease of maintenance access (crane not required)
3. ability to handle fouling
4. easy to clean if fouled
5. installation in heated building for wintertime operation
6. durable materials of construction (304 SS)

The North East Environmental Products Inc stripper quote and literature is included in Appendix A.

3.3 SETTLING SUMP - DESIGN BASIS

The settling basin with a volume of 2150 gallons has a residence time of 13 minutes at capacity flow of 165 gpm with no solids build-up in the basin. Precipitates that form in the air strippers and flow to the settling sump will collect in the settling basin for removal on a batch basis. The treated wastewater will overflow the settling sump weir into the outfall basin where it discharges to the local creek.

3.4 TREATMENT BUILDING - DESIGN BASIS

The treatment process is housed in a metal-sided building on a concrete slab with the following design features:

- A. Minimum 600 sq ft (30' by 20' allows room for two tray strippers, each 7'W x 13'L x 8'H, a small office area, and about 100 sq ft for future equipment).

- B. Metal siding and roof (roof peaked style).
- C. Sloped concrete floor with containment curb and low point drain sump.
- D. One 8-foot roll-up door.
- E. One 3'W x 6'8"L personnel door with panic bar.
- F. No windows or skylights.
- G. Fully-insulated with 9 ft eaves.
- H. Heating/air conditioning via wall-mounted unit.
- I. Wall-mounted ventilator.
- J. Wall-mounted chemical-type fire extinguisher.
- K. Electrical equipment suitable for non-hazardous classification.
- L. Interior wall finish - white vinyl backed insulation between studs - plywood screwed to metal studs where equipment requires wall mounting.
- M. Adequate interior lighting.

3.5 DESIGN FOR EXPANSION

The trench that serves RW-2 and RW-3 is designed with three 3 inch HDPE transfer lines for a future recovery well in the general area of RW-2 and RW-3. If additional recovery wells beyond 3 are required in this area, the three transfer lines would be used as one common header and a local metering building would be installed in the vicinity of RW-2.

The trench that serves RW-1 is designed with a 2 inch and a 4 inch HDPE transfer line. The 2 inch transfer line will be used for RW-1. If additional recovery wells are required, a local motor control center and metering building would be installed in the vicinity of RW-1 and the 4 inch transfer line would be used as a common header from this area to the Treatment Works Building.

The 2 strippers have a design capacity of 240 gpm (120 gpm each) for influent concentrations of 20 ppm TCE and effluent concentrations of 5 ppb TCE. The present design of 3 wells with a total of 165 gpm leaves 75 gpm of unused stripper capacity.

PROCESS MONITORING AND CONTROL

The entire system is designed to run without an operator in attendance. A weekly operator round is recommended to keep track of the mechanical condition of the equipment. The process is designed to be automated so that well pumps will shutdown and start-up based on well level. Critical conditions will be sensed with instruments and controls and alarms will notify the operator when a problem occurs via an automatic telephone dialer. The process parameters that are of interest to the operator, engineer or hydrogeologist will be accessible by telephone interface with the Data Acquisition and Process Control System.

4.1 RECOVERY WELL PUMPS CONTROL

The recovery well pumps will run based on the following criteria.

1. No Low Low Well Level Condition (level switch)
2. No Low Well Level Condition (level probe)
3. Stripper Blower Not Shut Down
4. No Treatment Building Sump Level High (Level Switch)

The recovery well pumps will start-up if shutdown based on the following criteria.

1. High Well Level Condition (level probe)
2. Stripper Blower Not Shut Down
3. No Treatment Building Sump Level High (Level Switch)

4.2 AIR STRIPPER BLOWER CONTROL

The stripper blowers will run under the following conditions:

1. No Stripper High Level (level switch)
2. No Blower Discharge Pressure High (pressure transmitter)

3. No Blower Discharge Pressure Low (pressure transmitter)
4. No Treatment Building Sump Level High (level switch)

4.3 ALARMS AND SENSING DEVICES

The following conditions will sound an alarm notifying the operator via the Security System:

1. Loss of electrical power to the system
2. Unauthorized intrusion into the Treatment Building
3. Smoke or fire in the Treatment Building
4. Low temperature in the Treatment Building
5. Stripper blower shutdown
6. Treatment Building sump high level
7. RW-1 High High level
8. RW-2 High High level
9. RW-3 High High level

4.4 INFORMATION AVAILABLE BY TELEPHONE

The following information will be accessible by telephone through the data acquisition and process control system.

1. RW-1 level
2. RW-1 flow rate
3. RW-2 level
4. RW-2 flow rate
5. RW-3 level
6. RW-3 flow rate
7. Stripper No. 1 Blower Pressure
8. Stripper No. 2 Blower Pressure
9. Level of 12 monitor wells

4.5 SITE SECURITY

The facility is designed to be monitored by a Data Acquisition and Process Control System 24 hours/day 7 days a week. The alarms outlined in Section 4.3 will alert a 24 hour a day security firm that a process or building alarm has occurred. The security firm will immediately contact the responsible operator. A back-up contact will always be listed in the event that the primary operator is unavailable. The operator or his back-up will respond to the alarm as quickly as possible.

In addition to facility security and process alarming, process information will be available by telephone to responsible parties. The information that will be available is listed in Section 4.4.

The process control design described in Sections 4.1 and 4.2 ensure the safe shutdown of the process in the event there is an equipment problem that requires process shutdown.

HANDLING, CONDITIONING, AND STORAGE OF RESIDUAL MATERIALS GENERATED DURING TREATMENT

The generation of iron and manganese oxides in the air stripper and in the settling sump are the only residual materials that are expected to be generated. The precipitate will collect in the settling sump for disposal as a non-hazardous waste. Since the concentration of iron, and manganese compounds in the well extraction water is not very well defined, the quantity of residual material can only be estimated. The material balance (Figure 3) shows that 6 pounds per day of iron and manganese oxide precipitates will collect in the settling sump. The settling pit has been included in the design to capture any precipitate that leaves the air strippers. This material will be transported to and disposed of in an approved manner after removal from the settling sump or from the air strippers during a maintenance turnaround. Based on 6 pounds per day of precipitates, it is estimated that the settling basin will require cleaning every 3 to 4 months removing approximately 600 pounds of solids for disposal.

FACILITY OPERATIONS AND MAINTENANCE

6.1 OPERATIONS AND MAINTENANCE MANUAL

An Operations and Maintenance Manual will be written for this operation. This manual will contain background, operations, and maintenance information according to the proposed Table of Contents presented in Appendix C.

6.2 PERSONNEL TRAINING

The Operations and Maintenance personnel will be trained on the system using the Operations Manual discussed in Section 6.1. These Operations and Maintenance personnel will meet all requirements for remedial treatment facilities for the State of Pennsylvania. Initial training will include textbook and field training with appropriate documentation as required by the State of Pennsylvania. Refresher training will be conducted annually or on a schedule required by the State. This annual refresher will also be documented appropriately.

All Operations and Maintenance changes to the facility will be reflected in the O & M Manual and training will be provided as necessary for new or revised systems.

6.3 MAINTENANCE PROGRAM

The maintenance program developed in the operations and maintenance manual will be implemented by Foster Wheeler or a contractor of their selection. The maintenance program that will be developed will be based on manufacturers' recommendations, Federal, State or local requirements and accepted standards for the industry. Maintenance procedures will be updated when equipment changes are made that require revised maintenance procedures. The responsible maintenance personnel will be properly trained on the required maintenance tasks.

REFERENCES

CH2M-Hill, January 1990, Crestwood Industrial Park Facility Site Evaluation, Morrison-Knudsen Co., Inc., Mountaintop, PA.

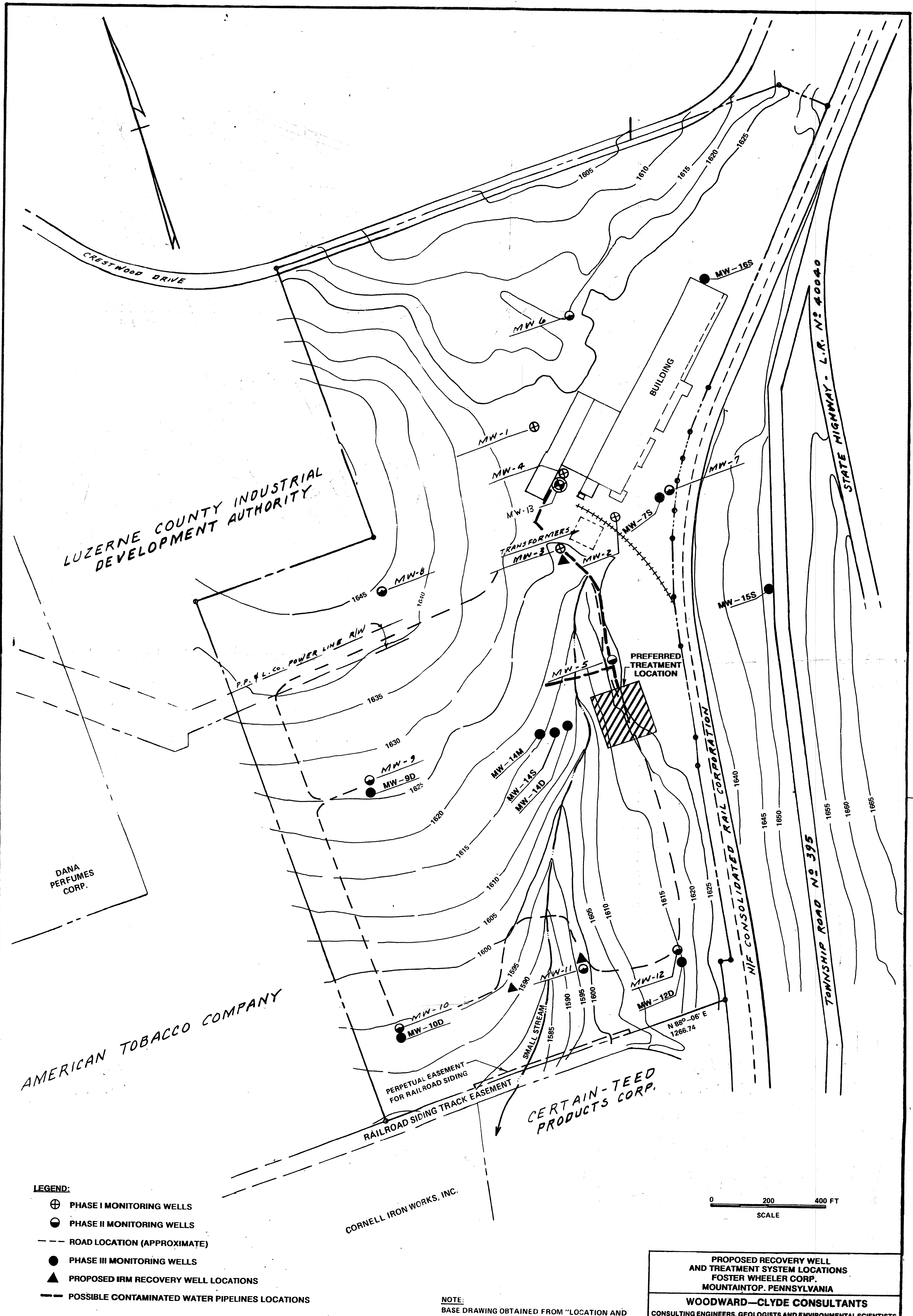
Glaeser, J.D., 1974, Upper Devonian Stratigraphy and Sedimentary Environments in Northeastern Pennsylvania, Penn. Geological Survey, General Geology Report 63.

Newport, T.G., 1977, Summary of Ground-Water Resources of Luzerne County, Pennsylvania, Penn. Geological Survey, Water Resource Report 40.

Woodward-Clyde Consultants (WCC), 1986, Field Investigation Report - Phase I, Foster-Wheeler Energy Corporation, Mountaintop, PA.

Woodward-Clyde Consultants (WCC), 1987, Field Investigation Report - Phase II, Foster-Wheeler Energy Corporation, Mountaintop, PA.

Figures



LEGEND:

- ⊕ PHASE I MONITORING WELLS
- PHASE II MONITORING WELLS
- - - ROAD LOCATION (APPROXIMATE)
- PHASE III MONITORING WELLS
- ▲ PROPOSED IRM RECOVERY WELL LOCATIONS
- - - POSSIBLE CONTAMINATED WATER PIPELINES LOCATIONS

NOTE:

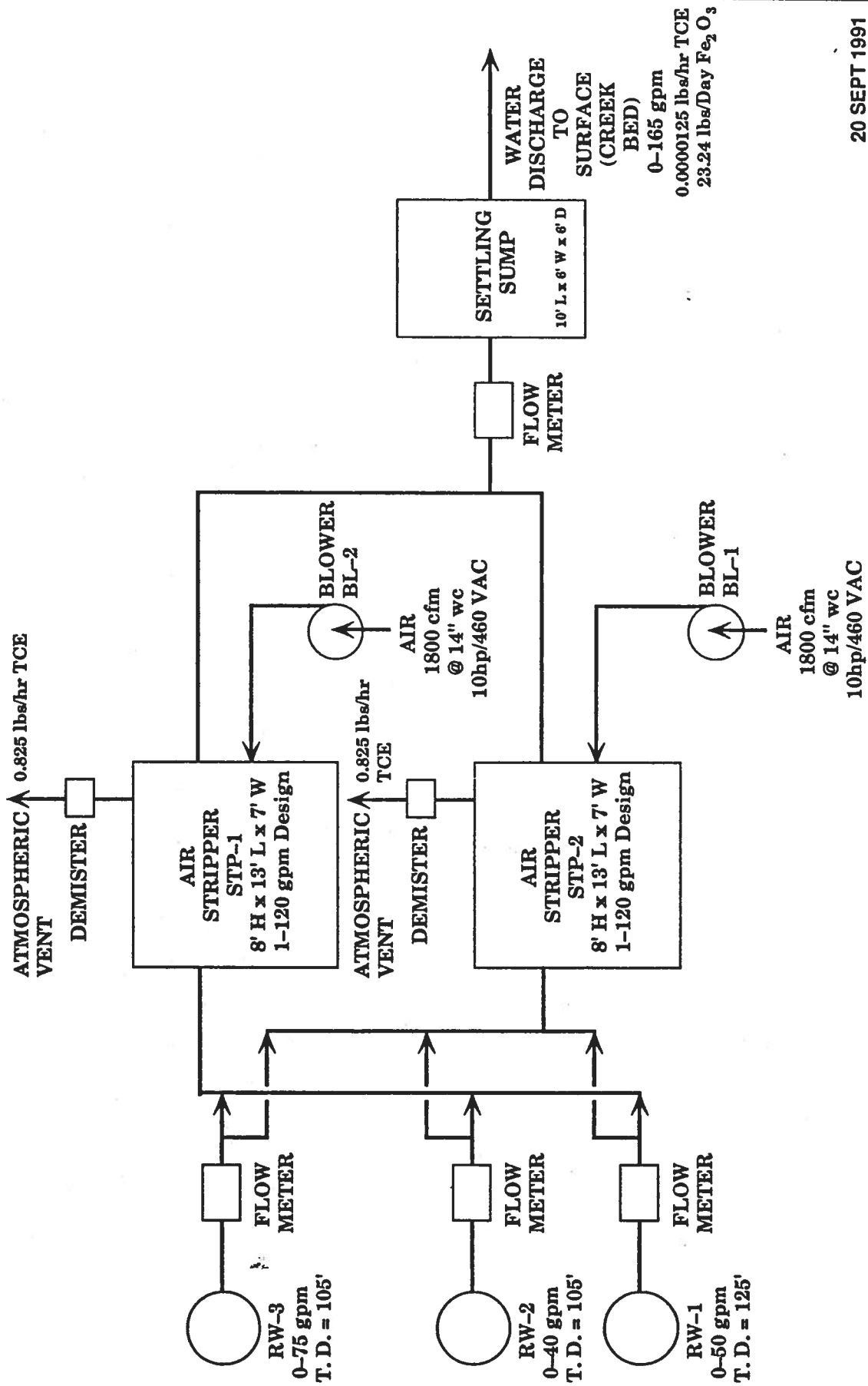
BASE DRAWING OBTAINED FROM "LOCATION AND ELEVATION OF WELLS", FOSTER WHEELER CORP. MOUNTAINTOP, PA., DATED JAN 14, 1987.

0 200 400 FT
SCALE

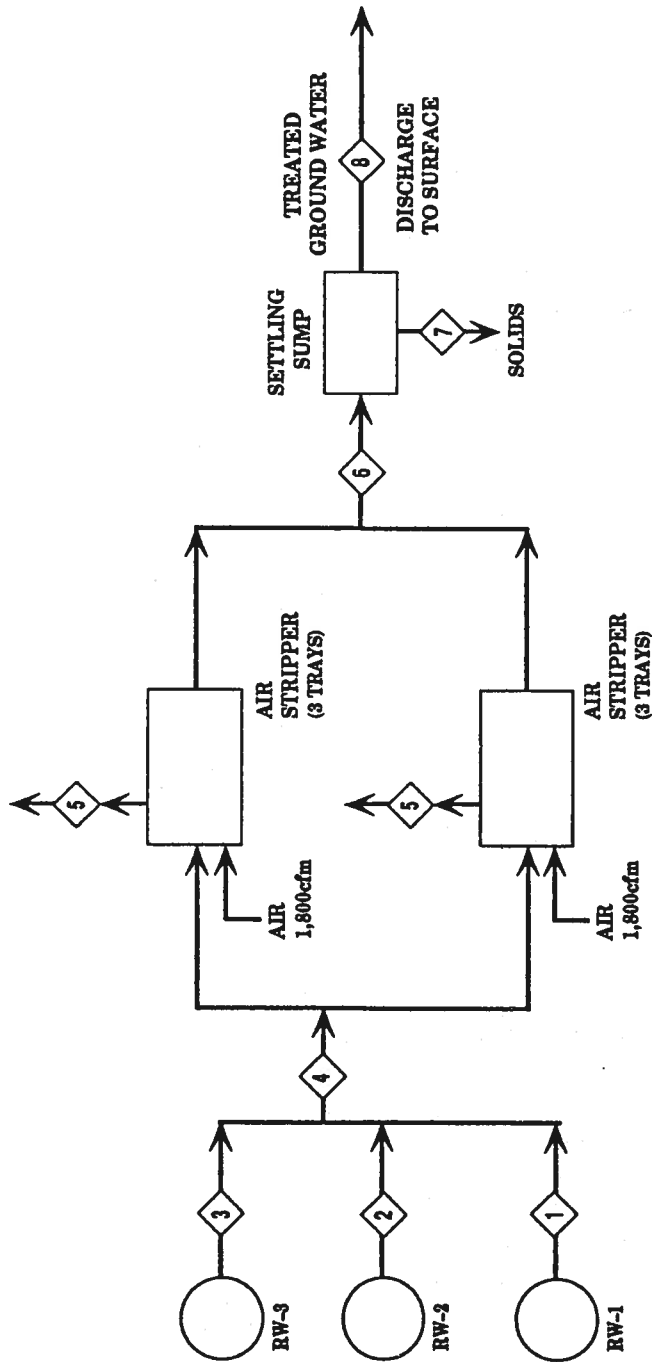
PROPOSED RECOVERY WELL AND TREATMENT SYSTEM LOCATIONS FOSTER WHEELER CORP. MOUNTAINTOP, PENNSYLVANIA		
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY		
DR. BY: TJD	SCALE: AS SHOWN	PROJ. NO.: 90C4170-08

FIGURE 2

FOSTER WHEELER ENERGY CORPORATION
GROUNDWATER REMEDIATION FACILITY
GENERAL SCHEMATIC WATER/WASTEWATER FLOW DIAGRAM
TREATMENT FACILITY SIZE, CAPACITY AND DIMENSION DIAGRAM



ATMOSPHERIC
VENT



Stream Number	1	2	3	4 ^A	5 ^B	6	7	8
Constituent	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum
Water - H ₂ O (gpm)	600,000 (50)	480,000 (40)	900,000 (75)	1,980,000 (165)	3,072	1,973,856	54	1,973,802
TCE - C ₂ HCl ₃	38.23	0.48	0.9	38.6	19,78985	0.0003		0.0003
Iron - Fe	0.9	4.8	9.0	19.8				
Manganese - Mn	0.3	0.34	0.45	.99				
Ferric Oxide - Fe ₂ O ₃						28.94	4.7	23.24
Manganic Oxide Mn ₂ O ₃						1.58	0.3	1.28
Air (ACFM)					209,434 (1800)	-		
TOTAL-lbs. per day	600,044.5	480,005.5	900,010.3	1,980,060.4	212,526	1,973,886	80	1,973,826

KEY:

A- Worse case scenario

B-Discharge for each stripper

PROCESS FLOW DIAGRAM

GROUND WATER TREATMENT SYSTEM
FOSTER WHEELER CORPORATION
MOUNTAINTOP, PA.

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY:	BAS	SCALE:	NONE	PROJ. NO.:	90C4170
CK'D. BY:	GEB	DATE:	17 SEPT 1991	FIG. NO.:	3

Appendix A

APPENDIX A

EQUIPMENT SPECIFICATIONS

APPENDIX A-1

WELL PUMP SPECIFICATION, P-1, 2, 3

Woodward-Clyde Consultants	Submersible Well Pump Data Sheet	Proj. No: 91C4524 Equip. No.: D-1 No. Req'd: ONE Sheet 1 of 1
----------------------------	-------------------------------------	--

Client: FOSTER WHEELER ENERGY CORP.		
Project: CRESTWOOD IND. PARK	Location: MOUNTAINTOP, PA	
Service: CONTAMINATED GROUNDWATER REMEDIATION		
Vendor: GRUNDFOS OR EQUAL	P. O. No.:	
Type: SUBMERSIBLE, MULTI-STAGE	Model: 40S30-9	Serial No.:
Driver Type: ELECTRIC MOTOR	Para. By: PUMP VENDOR	Mfd By: FRANKLIN ELECTRIC

OPERATING CONDITIONS	PERFORMANCE *
Liquid WATER ⁽¹⁾ GPM 25 (min) 30 (nor) 40 (max)	Proposal Curve No.
Duty BOTH INTERMITTENT & CONTINUOUS	RPM No. of Stages
Diff. Head, ft. 150	Min. Submergence Req'd, ft. Impeller Dia., in.
Min. Liq. Level above Suction, ft. 3	Eff% Min. Nor. Max.
Pump Depth, ft. 120 (BOTTOM)	Min. Continuous GPM NPSHR @ Max. GPM, ft.

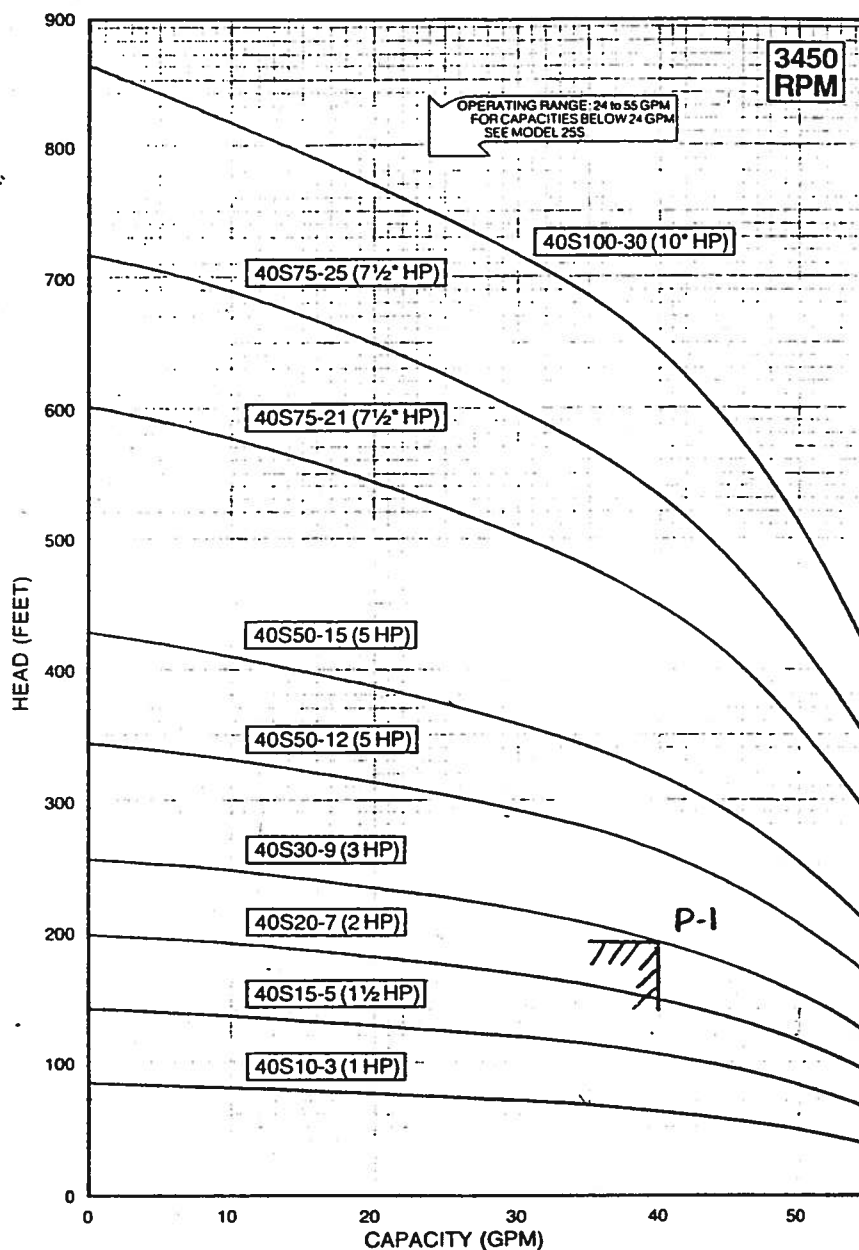
CONSTRUCTION	MOTOR *
Discharge Size & Type 2" NPT	HP 3 RPM 3450
Max. Width, in. 3 3/4 Min. Casing Dia., in. 6	Mfr. FRANKLIN
Shroud Req'd YES Dia., in. 5	Volts/Phase/Hertz 460/3/60
Built-in Check Valve YES	Service Factor

MATERIALS	Full Load Amps
Bowls 304 SS	Shaft Dia., in.
Impellers 304 SS	Material
Impeller Wedge 304 SS	Shell Material
Bowl Bearings NBR/316 SS	BEARINGS UPPER LOWER
Shaft 431 SS	Type
Motor Adapter 304 SS	Material
Discharge Adapter 304 SS	Lubrication
Motor Coupling 329/420/431 SS	Rating, Thrust, lb.
Suction Screen 304 SS	Lead Connection Type No. of Wires
Bolting 304 SS	Motor Leads, ft.

ACCESSORIES	WEIGHTS
Level Control BY OTHERS	Pump, lb. 16 Motor, lb. 55

REMARKS: * INFORMATION TO BE PROVIDED BY PUMP VENDOR AS PART OF QUOTATION. (1) WATER MAY HAVE UP TO 11 PPM TCE.

Prepared by: (b) (4)	REVISION	REVISION	REVISION
Date: 9-12-91			
App'd By:	By: Date:	By: Date:	By: Date:
Date:	App'd	App'd	App'd

**MODEL
40S****40 GPM****GRUNDFOS®****FLOW RANGE
24 to 55 GPM****PUMP OUTLET
2" NPT****PERFORMANCE CURVES****DIMENSIONS AND WEIGHTS**

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
40S10-3	1	25 ⁵ / ₈	3 ³ / ₄	32
40S15-5	1 ¹ / ₂	30 ¹ / ₂	3 ³ / ₄	37
40S20-7	2	33	3 ³ / ₄	41
40S30-9	3	43 ³ / ₈	3 ³ / ₄	65
40S50-12	5	51 ¹ / ₈	3 ³ / ₄	78
40S50-15	5	56 ¹ / ₈	3 ³ / ₄	84
40S75-21	7 ¹ / ₂ *	71 ³ / ₄	5 ¹³ / ₃₂	144
40S75-25	7 ¹ / ₂ *	78 ³ / ₈	5 ¹³ / ₃₂	148
40S100-30	10 *	87 ⁷ / ₈	5 ¹³ / ₃₂	172

A 6-inch minimum well diameter is required for the 40S75-21 (7 ¹/₂ HP), 40S75-25 (7 ¹/₂ HP), 40S100-30 (10 HP) models.

Specifications are subject to change without notice.

Woodward-Clyde Consultants	Submersible Well Pump Data Sheet	Proj. No: 91C4524 Equip. No.: P-2 No. Req'd: ONE Sheet 1 of 1
----------------------------	-------------------------------------	--

Client: FOSTER WHEELER ENERGY CORP.		
Project: CRESTWOOD IND. PARK	Location: MOUNTAINTOP, PA	
Service: CONTAMINATED GROUNDWATER REMEDIATION		
Vendor: GRUNDFOS OR EQUAL	P. O. No.:	
Type: SUBMERSIBLE, MULTISTAGE	Model: 40S30-9	Serial No.:
Driver Type: ELECTRIC MOTOR	Para. By: PUMP VENDOR	Mfd By: FRANKLIN ELECTRIC

OPERATING CONDITIONS	PERFORMANCE *
Liquid WATER ⁽¹⁾ GPM 25 (min) 35 (nor) 50 (max)	Proposal Curve No.
Duty BOTH INTERMITTENT & CONTINUOUS	RPM No. of Stages
Diff. Head, ft. 150	Min. Submergence Req'd, ft. Impeller Dia., in.
Min. Liq. Level above Suction, ft. 3	Eff% Min. Nor. Max.
Pump Depth, ft. 100 (BOTTOM)	Min. Continuous GPM NPSHR @ Max. GPM, ft.
CONSTRUCTION	MOTOR *

Discharge Size & Type 2" NPT	HP 3 RPM 3450
Max. Width, in. 3 3/4 Min. Casing Dia., in. 6	Mfr. FRANKLIN
Shroud Req'd YES Dia., in. 5	Volts/Phase/Hertz 460/3/60
Built-in Check Valve YES	Service Factor

MATERIALS	Full Load Amps
Bowls 304 SS	Shaft Dia., in.
Impellers 304 SS	Material
Impeller Wedge 304 SS	Shell Material
Bowl Bearings NBR/316SS	BEARINGS UPPER LOWER
Shaft 431 SS	Type
Motor Adapter 304 SS	Material
Discharge Adapter 304 SS	Lubrication
Motor Coupling 329/420/431 SS	Rating, Thrust, ft.
Suction Screen 304 SS	Lead Connection Type No. of Wires
Bolting 304 SS	Motor Leads, ft.

ACCESSORIES	WEIGHTS
Level Control BY OTHERS	Pump, lb. 16 Motor, lb. 55

REMARKS:	
* INFORMATION TO BE PROVIDED BY PUMP VENDOR AS PART OF QUOTATION.	
(1) WATER MAY HAVE UP TO 2 PPM TCE	

Prepared by: (b) (4)	REVISION	REVISION	REVISION
Date: 9-12-91			
App'd By:	By: Date:	By: Date:	By: Date:
Date:	App'd	App'd	App'd

**MODEL
40S**

40 GPM

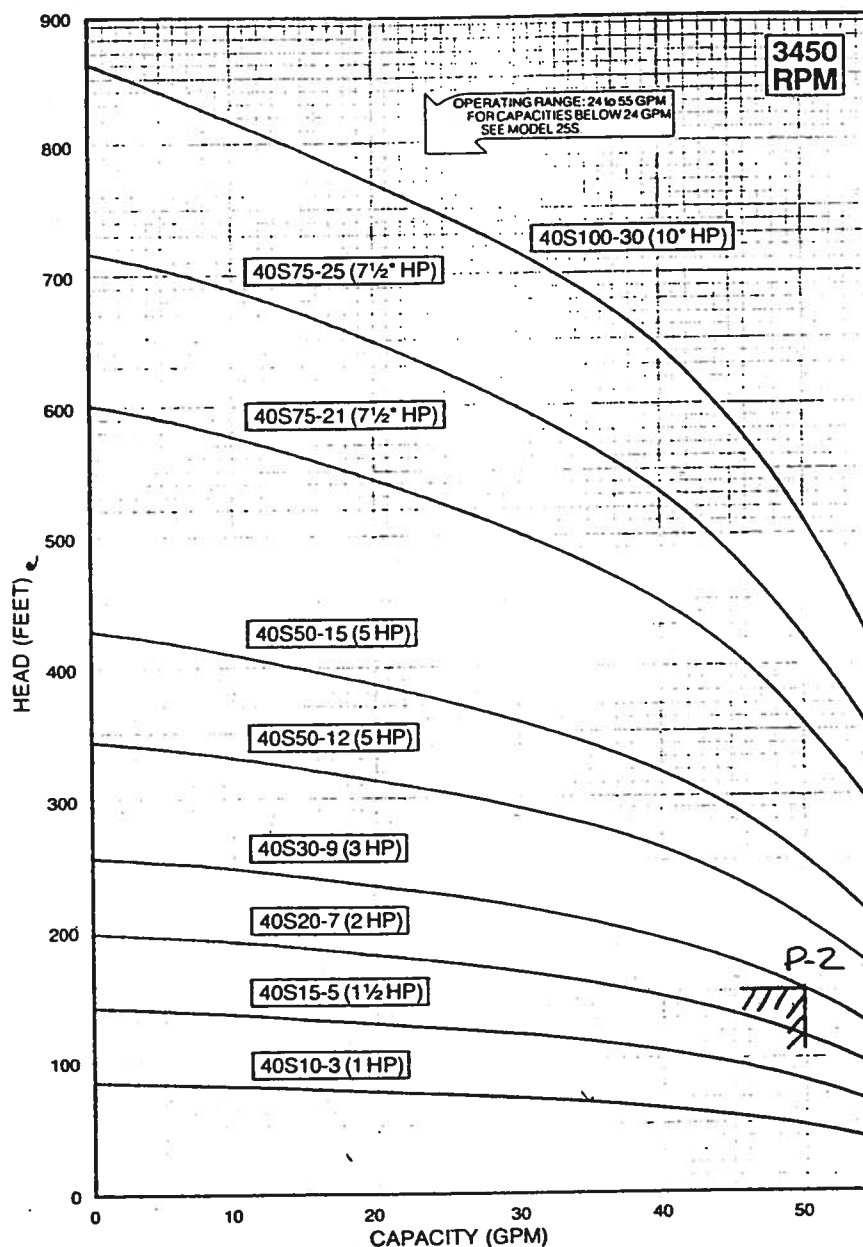
GRUNDFOS®

FLOW RANGE
24 to 55 GPM

PUMP OUTLET
2" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
40S10-3	1	25 5/8	3 3/4	32
40S15-5	1 ½	30 ½	3 3/4	37
40S20-7	2	33	3 3/4	41
40S30-9	3	43 3/8	3 3/4	65
40S50-12	5	51 1/8	3 3/4	78
40S50-15	5	56 1/8	3 3/4	84
40S75-21	7 ½*	71 3/4	5 13/32	144
40S75-25	7 ½*	78 3/8	5 13/32	148
40S100-30	10*	87 7/8	5 13/32	172

6-inch minimum well diameter is required for the 40S75-21 (7½ HP), 40S75-25 (7½ HP), 40S100-30 (10 HP) models.

Specifications are subject to change without notice.

Woodward-Clyde Consultants	Submersible Well Pump Data Sheet	Proj. No: <u>91C4524</u> Equip. No.: <u>P-3</u> No. Req'd: <u>ONE</u> Sheet <u>1</u> of <u>1</u>
----------------------------	-------------------------------------	---

Client: <u>FOSTER WHEELER ENERGY CORP.</u>	
Project: <u>CRESTWOOD IND. PARK</u>	Location: <u>MOUNTAINTOP, PA</u>
Service: <u>CONTAMINATED GROUNDWATER REMEDIATION</u>	
Vendor: <u>GRUNDFOS OR EQUAL</u>	P. O. No.:
Type: <u>SUBMERSIBLE, MULTI-STAGE</u>	Model: <u>60S50-9</u> Serial No.:
Driver Type: <u>ELECTRIC MOTOR</u>	Pump By: <u>PUMP VENDOR</u> Mfr'd By: <u>FRANKLIN ELECTRIC</u>

OPERATING CONDITIONS	PERFORMANCE *
Liquid <u>WATER⁽¹⁾</u> GPM <u>40</u> (min) <u>60</u> (nom) <u>75</u> (max)	Proposal Curve No.
Duty <u>BOTH INTERMITTENT & CONTINUOUS</u>	RPM No. of Stages
Diff. Head, ft. <u>150</u>	Min. Submergence Req'd, ft. Impeller Dia., in.
Min. Liq. Level above Suction, ft. <u>3</u>	Eff% Min. Nor. Max.
Pump Depth, ft. <u>100</u> (BOTTOM)	Min. Continuous GPM NPSHR @ Max. GPM, ft.

CONSTRUCTION	MOTOR *
Discharge Size & Type <u>2" NPT</u>	HP <u>5</u> RPM <u>3450</u>
Max. Width, in. <u>3 3/4</u> Min. Casing Dia., in. <u>6</u>	Mfr. <u>FRANKLIN</u>
Shroud Req'd <u>YES</u> Dia., in. <u>5</u>	Volts/Phase/Hertz <u>460/3/60</u>
Built-in Check Valve <u>YES</u>	Service Factor

MATERIALS	Full Load Amps
Bowls <u>304 SS</u>	Shaft Dia., in.
Impellers <u>304 SS</u>	Material
Impeller Wedge <u>304 SS</u>	Shell Material
Bowl Bearings <u>NBR</u>	BEARINGS UPPER LOWER
Shaft <u>431 SS</u>	Type
Motor Adapter <u>304 SS</u>	Material
Discharge Adapter <u>304 SS</u>	Lubrication
Motor Coupling <u>329/420/431 SS</u>	Rating, Thrust, lb.
Suction Screen <u>304 SS</u>	Lead Connection Type No. of Wires
Bolting <u>304 SS</u>	Motor Leads, ft.

ACCESSORIES	WEIGHTS
Level Control <u>BY OTHERS</u>	Pump, lb. <u>30</u> Motor, lb. <u>74</u>

REMARKS:	
* INFORMATION TO BE PROVIDED BY PUMP VENDOR AS PART OF QUOTATION.	
(1) WATER MAY HAVE UP TO 2 PPM TCE.	

Prepared by: <u>(b) (4)</u>	REVISION	REVISION	REVISION
Date: <u>9-12-91</u>			
App'd By:	By: Date:	By: Date:	By: Date:
Date:	App'd	App'd	App'd

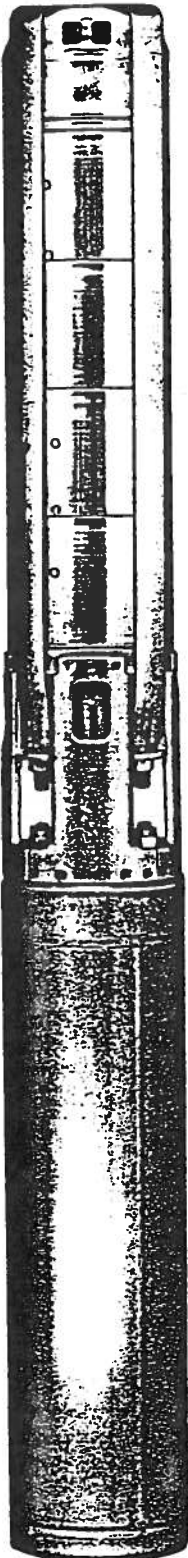
MODEL
60S

60 GPM

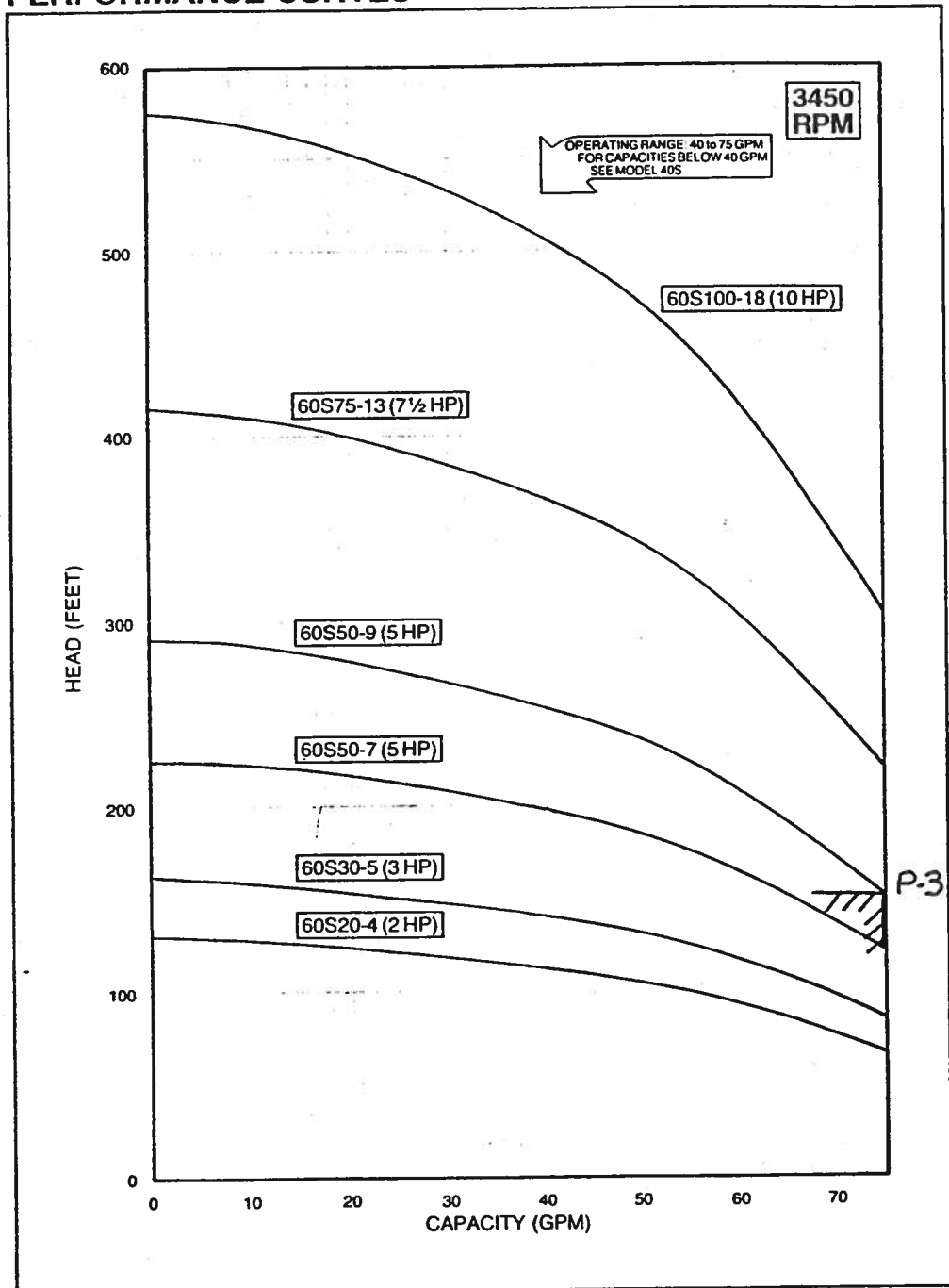
GRUNDFOS

FLOW RANGE
40 to 75 GPM

PUMP OUTLET
2" NPT



PERFORMANCE CURVES



PHYSICAL DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
60S20-4	2	31 1/4	3 3/4	39
60S30-5	3	40 3/4	3 3/4	64
60S50-7	5	48 5/8	3 3/4	75
60S50-9	5	53 3/4	3 3/4	80
60S75-13	7 1/2	70	3 3/4	105
60S100-18	10	97 1/4	3 3/4	160

Specifications are subject to change without notice.

Grundfos Stainless Steel Submersible Pumps

Stainless Steel Quality and Customer Satisfaction

At Grundfos, we pride ourselves in producing a line of pumps that is unsurpassed in quality, performance and reliability. Unlike other pump manufacturers, Grundfos uses *high grade stainless steel for nearly every pump component*, including impellers, diffusers, shafts, straps, check valves, couplings, and cable guards. Stainless steel construction, advanced engineering design, and automated manufacturing processes make Grundfos the quality leader in today's submersible pump market.

At Grundfos *customer satisfaction* is just as important as producing a superior product. Our national distribution network assures prompt deliveries and a ready source of product information and pump selection assistance.

Education and training play an important role in our total customer service package. Formal training programs held at our factory and regional distribution centers develop a greater understanding of the wide range and uses of our products.

A Heart of Steel

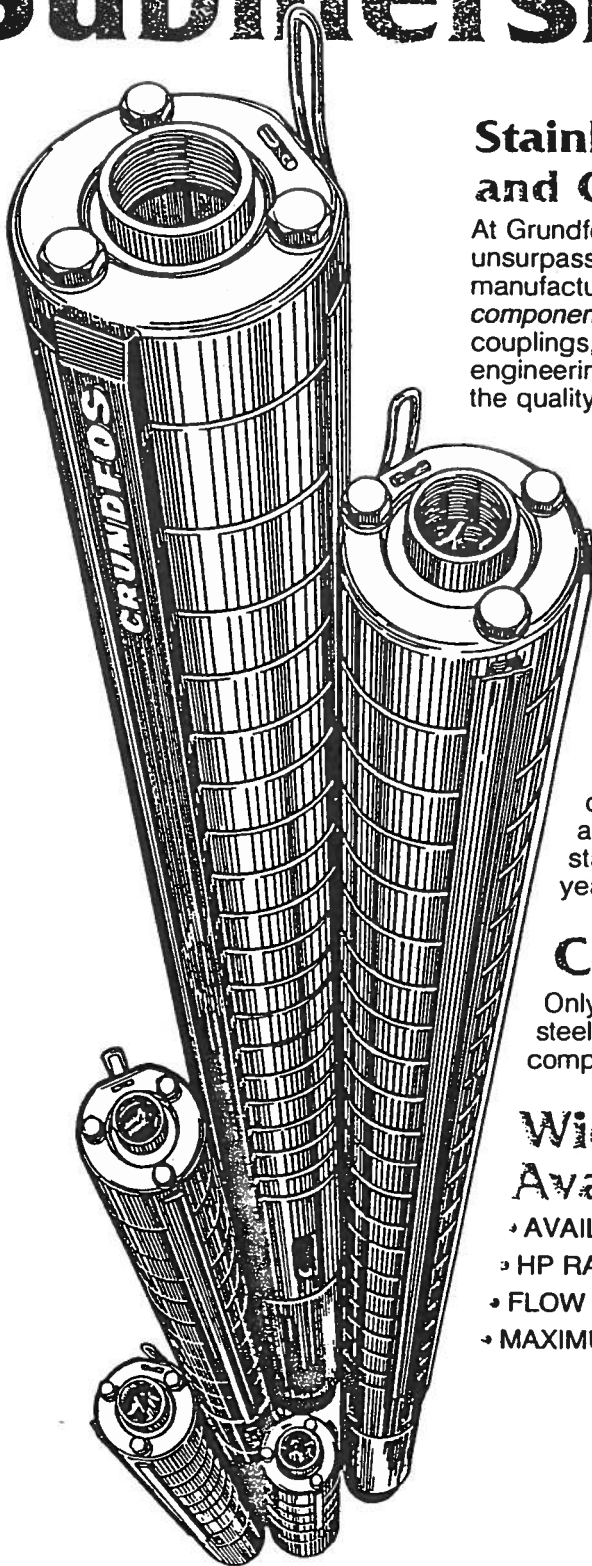
Fabricated to exacting tolerances, stainless steel is found at the heart of every Grundfos pump, providing high resistance to wear, corrosion, and abrasion. With the inherent smooth surfaces of fabricated stainless steel, specified performance levels are maintained over many years of service, unlike pumps using plastics, cast iron, or cast bronze.

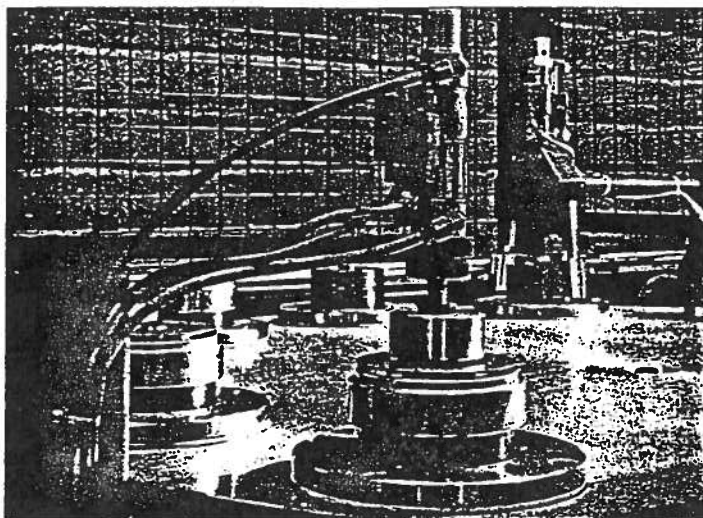
Competitively Priced

Only Grundfos has been able to combine the superiority of stainless steel with advanced design and production techniques to produce a competitively priced stainless steel pump.

Wide Operating Ranges Available

- AVAILABLE SIZES: 4 to 10-inch and larger well sizes
- HP RANGE: $\frac{1}{3}$ to 250 HP
- FLOW RANGE: 1.2 to 1,300 GPM
- MAXIMUM WELL DEPTH: 1,980 feet





AUTOMATED DESIGN AND MANUFACTURING PROCESSES ASSURE QUALITY CONSTRUCTION, TOP PERFORMANCE, AND LONG OPERATING LIFE.

Exclusive Grundfos Designs

1. FAIL-SAFE CHECK VALVE DESIGN: Grundfos stainless steel check valves are built into the top pump chamber to prevent backflow. These positive, non-clogging, non-slamming valves are sized to meet the maximum pressures for each model.

2. STAINLESS STEEL FABRICATION YIELDS MAXIMUM HYDRAULIC PERFORMANCE: Grundfos fabrication techniques for stainless steel permit ideal shaping of impeller and diffuser vanes for top performance and high efficiency.

3. EXCLUSIVE PRIMING INDUCER PROTECTS AGAINST DRY RUNNING: The exclusive Grundfos priming inducer protects against damage due to dry running should water levels drop unexpectedly in the well. Located inside the suction interconnector at the pump inlet, this small, axial flow screw provides enough water to lubricate the pump until the well has time to recover.

Pump Selection Guide

MODEL	MIN. WELL SIZE	FLOW RANGE (GPM)	MAX. HEAD (FEET)	MAX. HEAD (PSI)
-------	----------------	------------------	------------------	-----------------

4 Inch & Larger Wells

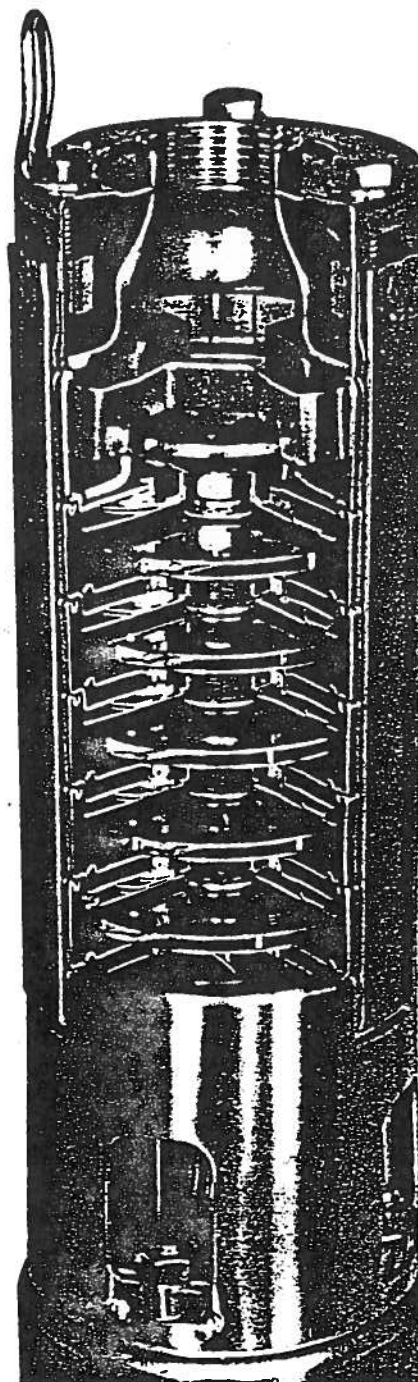
5S	4"	1.2-7	870	377
7S	4"	3-10	680	294
10S	4"	5-14	950	411
16S	4"	10-20	990	429
25S	4"	18-32	630	273
40S	4" & 6"	24-55	755	327
60S	4"	40-75	505	219
75S	4"	45-95	460	199

6, 8, 10-Inch & Larger Wells

80S	6"	48-110	845	366
135S	6"	75-200	835	361
225S	6" & 8"	150-290	680	294
375S	8"	230-500	310	134
600S	10"	350-800	420	182
1000S	10"	600-1300	575	249

Deep Set

5S-DS	4"	1.2-7	1330	576
10S-DS	4" & 5"	5-14	1550	671
16S-DS	6"	10-20	1980	857
25S-DS	6"	18-32	1255	543
40S-DS	6"	24-55	1655	716
80S-DS	6" & 8"	48-110	1745	755
135S-DS	8"	75-200	1910	827
225S-DS	8"	150-290	1220	528
375S-DS	8"	230-500	1080	467
600S-DS	10"	350-800	590	255
1000S-DS	10"	600-1300	860	372



UNDERGROUND WASTEWATER PIPING SPECIFICATIONS

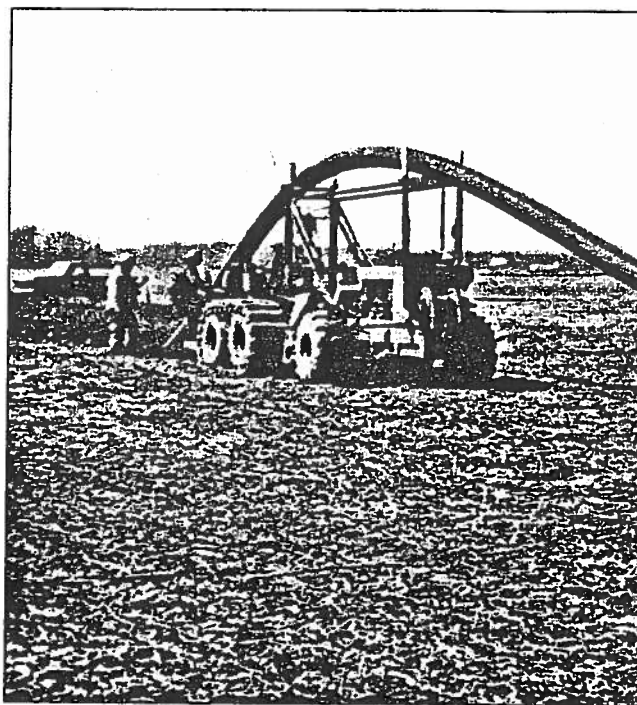
	Woodward-Clyde Engineering Specification	Standard Number P																
By: J. D. Porter	Piping Material Specification	Page 1 of 1																
Approved: <u>JDP</u>		Issued: 09-13-91																
		Revised: _____																
<p>Recommended Service: Buried groundwater transfer.</p> <table> <thead> <tr> <th><u>Pipe</u></th> <th><u>Description</u></th> </tr> </thead> <tbody> <tr> <td>2" and 3"</td> <td>SDR 11 (2"), SDR 17 (3"), coils, Ultra-high molecular weight, high density polyethylene pipe meeting ASTM D3035 and F714, Plexco EHMW 3408, Driscopipe 8600 or approved equal.</td> </tr> <tr> <td>4"</td> <td>SDR 17, 40 foot straight lengths, Ultra-high molecular weight, high density polyethylene pipe meeting ASTM D3035 and F714, Plexco EHMW 3408, Driscopipe 8600 or approved equal.</td> </tr> </tbody> </table> <p><u>Fittings</u></p> <table> <tbody> <tr> <td>2" thru 4"</td> <td>Molded, pressure rating equal to or better than pipe, butt ends, Ultra-high molecular weight, high density polyethylene, Plexco, Driscopipe or approved equal.</td> </tr> </tbody> </table> <p><u>Flanges</u></p> <table> <tbody> <tr> <td>2" thru 4"</td> <td>ANSI B16.5, Class 150, epoxy coated steel, lap joint style, for use with flange adapters as furnished by the pipe manufacturer.</td> </tr> </tbody> </table> <p><u>Bolts</u></p> <table> <tbody> <tr> <td>All Sizes</td> <td>Hex head machine bolts, 304 stainless steel, with heavy hex nuts.</td> </tr> </tbody> </table> <p><u>Gaskets</u></p> <table> <tbody> <tr> <td>All Sizes</td> <td>1/16" Neoprene, ring type, JM Style 103 or approved equal.</td> </tr> </tbody> </table> <p><u>Joining Method</u></p> <table> <tbody> <tr> <td>All Sizes</td> <td>Pipe and fittings shall be machine joined by the thermal butt fusion method as recommended by the pipe manufacturer.</td> </tr> </tbody> </table>			<u>Pipe</u>	<u>Description</u>	2" and 3"	SDR 11 (2"), SDR 17 (3"), coils, Ultra-high molecular weight, high density polyethylene pipe meeting ASTM D3035 and F714, Plexco EHMW 3408, Driscopipe 8600 or approved equal.	4"	SDR 17, 40 foot straight lengths, Ultra-high molecular weight, high density polyethylene pipe meeting ASTM D3035 and F714, Plexco EHMW 3408, Driscopipe 8600 or approved equal.	2" thru 4"	Molded, pressure rating equal to or better than pipe, butt ends, Ultra-high molecular weight, high density polyethylene, Plexco, Driscopipe or approved equal.	2" thru 4"	ANSI B16.5, Class 150, epoxy coated steel, lap joint style, for use with flange adapters as furnished by the pipe manufacturer.	All Sizes	Hex head machine bolts, 304 stainless steel, with heavy hex nuts.	All Sizes	1/16" Neoprene, ring type, JM Style 103 or approved equal.	All Sizes	Pipe and fittings shall be machine joined by the thermal butt fusion method as recommended by the pipe manufacturer.
<u>Pipe</u>	<u>Description</u>																	
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All Sizes	1/16" Neoprene, ring type, JM Style 103 or approved equal.																	
All Sizes	Pipe and fittings shall be machine joined by the thermal butt fusion method as recommended by the pipe manufacturer.																	

Performance Properties for Polyethylene Piping Products

The PLEXCO EHMW PE 3408 POLYETHYLENE PIPING SYSTEM provides many desirable properties for piping:

- High strength and stiffness to withstand internal pressure and external loads.
- Chemical resistance to withstand corrosive chemicals (pH from 1 to 14), and aggressive soils.
- Flexibility, toughness, light weight, and impact resistance for easy, low cost installation, narrower trenches (reduced excavation), and fewer expensive fittings.
- Resistance to environmental stress cracking for long term performance in harsh environments.
- Heat fusion joining for strong, lifetime leak-tight joints.
- Resilience for resistance to surges and durable performance under extremes of temperature.
- Long term strength for extended life and performance.
- Lifetime low resistance to liquid flows for reduced pumping and operating costs when compared to conventional piping materials.

The PLEXCO EHMW PE 3408 PIPING SYSTEM is a combination of high performance, high quality materials, and carefully controlled processing into a finished product. In addition, the product must be designed and engineered to serve its intended purpose. PLEXCO's high standards and specifications for materials, manufacturing, and quality are among the most stringent in the industry.



Installation of PE pipe

Table 1. Cell Classification Descriptions*

Cell Classification of PLEXCO EHMW PE 3408	Property	Cell Classification Limits	Typical Value for PLEXCO EHMW PE 3408 (PE 3408 Compound)
3	DENSITY per ASTM D-1505, gm/cm ³	0.941 - 0.955	0.955
4	MELT INDEX per ASTM D-1238, gm/10 min	< 0.15	0.10
5	FLEXURAL MODULUS per ASTM D-790, psi	110,000 - 160,000	133,000
4	TENSILE STRENGTH per ASTM D-638, psi	3000 - 3500	3500
3	ENVIRONMENTAL STRESS CRACK RESISTANCE per ASTM D-1693, Failure % = hours	F ₂₀ = 192	F ₀ > 5000
4	HYDROSTATIC DESIGN BASIS per ASTM D-2837, psi	1600	1600
C	COLOR & ULTRAVIOLET STABILIZER	> 2% Carbon Black	2% to 3% Carbon Black

*Base resin. Pipe values may vary.

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PLEXCO EHMW PE 3408 HIGH DENSITY POLY-ETHYLENE PIPING PRODUCTS are made from a high density, extra high molecular weight compound with a broad range molecular weight distribution. This material must meet stringent PLEXCO specifications, a PE 3408 designation, and ASTM D-1248 requirements for a Type III, Class C, Category 5, Grade P34 material. A more definitive description is developed under ASTM D-3350, where various physical properties and range values are defined by a cell classification system. For PLEXCO EHMW PE 3408 HIGH DENSITY POLYETHYLENE, the cell classification is 345434C. See Table 1.

However, the PLEXCO compound does not merely meet the various cell range requirements. Many of the properties are well within the range, or well beyond the minimum necessary to qualify for the cell classification. For example, density is at the high limit of the range, flexural modulus (stiffness) is firmly in the range, tensile strength is at the high limit of the range, and ESCR is far beyond the minimum requirement.

An important property is not completely described under ASTM D-1248 or ASTM D-3350. Elevated temperature performance cannot be described by ambient temperature data. PLEXCO compound has been validated under elevated temperature testing specified by PPI (the Plastics Pipe Institute), and has a Hydrostatic Design Basis (Long Term Hydrostatic Strength) of 800 psi at 140°F, the highest rating available for a PE 3408.

PLEXCO EHMW PE 3408 HIGH DENSITY POLYETHYLENE is designed to incorporate the desirable properties for a high performance, high quality polyethylene piping product that rigorous municipal and industrial applications demand. High density contributes high tensile strength, high surface hardness, increased stiffness, outstanding chemical resistance, and resistance to softening and distortion under pressure service to 140°F, or gravity flow service to 180°F.

Extra high molecular weight, about 330,000, contributes exceptional strength, toughness, impact resistance, and resistance to abrasion. Broad range molecular weight distribution contributes to easy, consistent fusion joining.

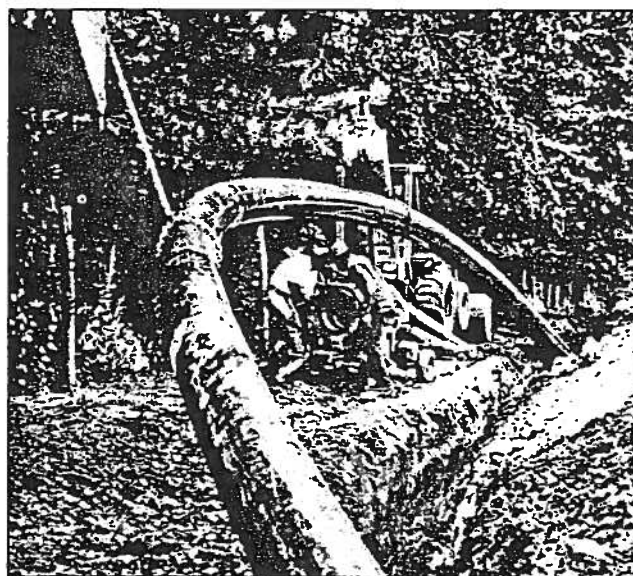
The highest cell classification requirement for environmental stress cracking resistance under ASTM D-3350 will allow 2 out of 10 samples to fail within 192 hours.

PLEXCO EHMW PE 3408 HIGH DENSITY POLY-ETHYLENE goes far beyond this requirement by exceeding 5000 hours without failure. This outstanding resistance to environmental stress cracking means that PLEXCO EHMW PE 3408 HIGH DENSITY POLY-ETHYLENE can carry aggressive materials in hostile environments where other pipe materials may fail.

To guard against degradation from ultraviolet light, 2% to 3% of a finely divided carbon black is compounded into PLEXCO EHMW PE 3408 HIGH DENSITY POLYETHYLENE. This stabilizer system permits above ground service or storage without fear of loss of performance or quality.

PLEXCO has taken great care to prepare a superior material that provides the quality, high performance, toughness, flexibility, and durability required to meet difficult municipal and industrial services. However, the municipal or industrial user purchases more than just a material, he buys a product for an intended service.

Before a material can be offered as a product, it must be thermally processed by extrusion or molding. These critical, thermal processes must be properly performed to retain the designed-in high performance and quality of the material. To assure quality conversion to high performance products, PLEXCO has obtained PPI verification that the PE 3408 material rating is retained after processing into pipe and fittings. This post-conversion PPI listing as "PLEXCO P34CH" PE 3408 material demonstrates the PLEXCO commitment to quality and performance.



Flexible PE pipe

General Design Guidelines for PLEXCO EHMW PE 3408 Polyethylene Piping Products

Sizes and Pressure Ratings

PLEXCO polyethylene piping products are sized by a controlled outside diameter and wall thickness. Outside diameters are generally the same as steel pipe. The ratio of the outside diameter to the minimum wall thickness is the Standard Dimension Ratio, SDR, of the pipe. Pipe pressure ratings correspond to the SDR number. Higher pressure ratings require thicker walls, and, therefore, lower SDR numbers. Due to the controlled outside diameter, high pressure pipes with thick walls also have smaller bores than low pressure pipes of the same outside diameter.

The OD controlled, SDR system provides PLEXCO customers with a wide variety of pressure ratings to meet demanding service requirements at low cost. Pipe and tubing sizes for both pressure and gravity flow systems are available. PLEXCO is an industry leader in extrusion technology, and offers large diameter, high pressure polyethylene pipe in standard pressure ratings up to 255 psi. Heavier wall pipe is available upon request. Contact your PLEXCO SALES REPRESENTATIVE or PLEXCO DISTRIBUTOR with your special application needs.

The nominal pressure rating is for water at 73°F. PRESSURE RATINGS MAY BE SIGNIFICANTLY AFFECTED BY ELEVATED TEMPERATURE AND THE PRESENCE OF CERTAIN CHEMICALS IN SUFFICIENT CONCENTRATION. PLEXCO EHMW PE 3408 high density polyethylene pipe is rated for pressure service from -50°F and lower, to +140°F by applying an appropriate design factor. Nonpressure service to +180°F is permissible. The brittleness temperature is -180°F.

Surge Pressures and Subfreezing Temperatures

For moderate flow velocities, a surge allowance within the system pressure rating is not required. The PLEXCO EHMW PE 3408 high density polyethylene piping system will tolerate surge pressures such as water hammer of up to 1-1/2 times the system pressure rating without damage. Harsh climates, unstable soils, and frost heave have little effect on this flexible, elastic piping system. Water may be frozen solid in the pipe without damage to the pipe.

Thermal Expansion and Contraction

When subjected to a temperature change, unrestrained (not buried) polyethylene pipe will expand or contract. A rule-of-thumb is 1/10/100 — allow 1" for a 10°F change for each 100 feet of pipe.

Allow piping to stabilize to trench bottom or casing temperature before final tie-in or backfilling. Surface or above ground installations should be snaked back and forth to allow for thermal length change. Restraining anchors may be necessary to maintain the pipeline in the right-of-way.

Chemical Resistance

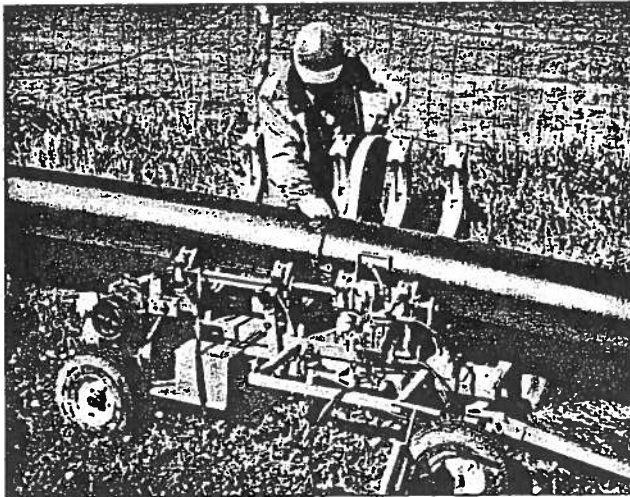
Very few chemicals will have an effect upon PLEXCO EHMW PE 3408 polyethylene. Those that do may either be unsuitable for transport, or may reduce the pressure rating. Both concentration and temperature may be factors. Most plastics used for piping, such as PE, PVC, CPVC, PB, and PP, may be permeated by certain chemicals, and in some rare cases, chemically saturated soils may be of concern if the purity of the fluid in the pipe must be maintained. In the majority of installations, permeation need not be considered.

Joining

PLEXCO EHMW PE 3408 high density polyethylene pipe and fittings may be joined by the heat fusion process which produces homogeneous, sealed, leak tight joints. In the field, the broad molecular weight distribution of the PLEXCO system provides for ease of construction, and consistent fusion joining under adverse jobsite conditions. USE PLEXCO JOINING PROCEDURES, AVAILABLE FROM YOUR PLEXCO REPRESENTATIVE, TO HEAT FUSE PLEXCO EHMW PE 3408 POLYETHYLENE PIPING PRODUCTS. PLEXCO distributors can assist you with heat fusion equipment purchase or rental.

A leakage allowance common to gasketed, bell jointed pipes is unnecessary with the PLEXCO piping system, as there are no gaskets to leak or deteriorate. Joint restraints are not required, and thrust blocks are necessary only under unusual circumstances. The longer lengths, 40 feet or greater, mean fewer joints, and, since the pipes are butted end-to-end, there is little waste, and no loss such as the several inches of pipe that must be inserted into a bell type joint.

Flanged adaptors and mechanical connectors may also be used to join the system, or to connect to other piping materials. POLYETHYLENE CANNOT BE SOLVENT CEMENTED.



Fusion joining of HDPE pipe

Installation

The PLEXCO piping system may be directly buried, sliplined in a casing, submerged, laid on the surface, or suspended.

Figure 1 shows the direct burial of polyethylene pipe, which should be encapsulated in a uniform grade of quality, compacted fill material. Compaction of 85% proctor density or greater will enable higher surface loads and limit deflection. The outstanding flexibility of the PLEXCO system reduces the need for costly fittings required with conventional piping materials. The pipe will follow the lay-of-the-land, and may be cold bent to a radius of 20 to 25 times the pipe outside diameter. When fittings are present in the bend, the radius should be at least 125 pipe diameters.

Sliplining installations may be subject to thermal length changes, and should be designed with a minimum of 10% clearance between the liner OD and the casing bore. For thinwall sewer liners, external hydrostatic load due to high water table or flood conditions may determine the minimum pipe SDR requirement.

Table 2. External Hydraulic Load*

SDR	Water Height Above Pipe	
	50 Year	1 Month
32.5	2.8 ft.	3.8 ft.
26.0	5.6 ft.	7.6 ft.
21.0	10.9 ft.	14.8 ft.
17.0	21.2 ft.	29.0 ft.

* Includes a design factor in accordance with PPI recommendations.

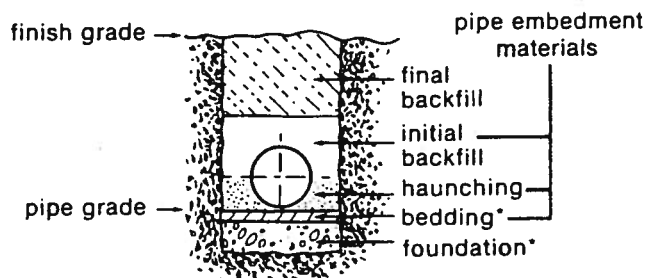
Figure 2 represents sanitary sewer sliplining. Prior to sliplining, the sewer should be hydraulically cleaned, and cleared of roots and debris. TV inspection can assist with the location of service connections and structural deterioration. In general, service connections, the pulling pit, and badly deteriorated areas will require excavation.

Submerged installations such as river and lake crossings, or outfalls will require weights to keep the pipe submerged. PLEXCO EHMW PE 3408 high density polyethylene is about 4-1/2% lighter than water and will float even when water filled. Anchors may be required if significant cross currents are encountered.

Surface installations will be significantly affected by thermal length changes. Snaking the pipe back and forth can allow extra pipe length so that cold weather contraction may be controlled. Restraining anchors may be necessary to maintain the pipeline within the right-of-way. Elevated temperature pressure ratings may apply if the pipeline is exposed to sunlight heating. Large diameter fabricated fittings may require external mechanical reinforcement to withstand bending and tensile forces from thermal length changes.

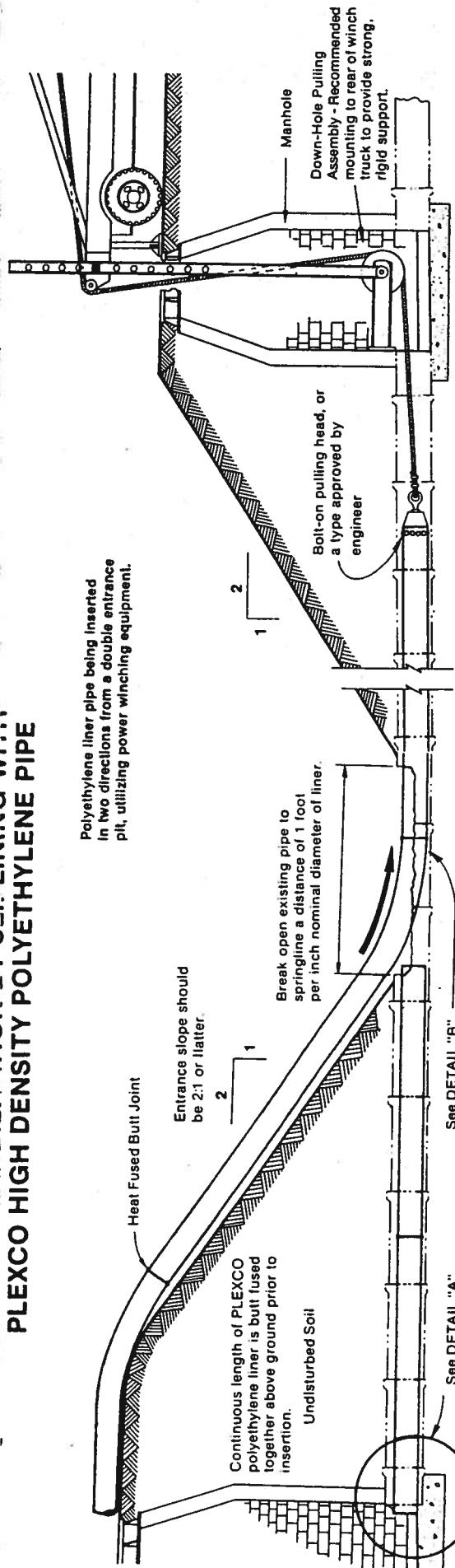
Suspended installations will be subject to the same thermal length change forces as a surface pipeline. Pipeline supports should be at least one pipe diameter wide and cradle the bottom 180° of the pipe. Supports will need to be spaced according to the pipe diameter, SDR, and the weight of the fluid in the pipe. The recommended maximum deflection between supports is 1".

Fig. 1 - Trench construction and terminology.

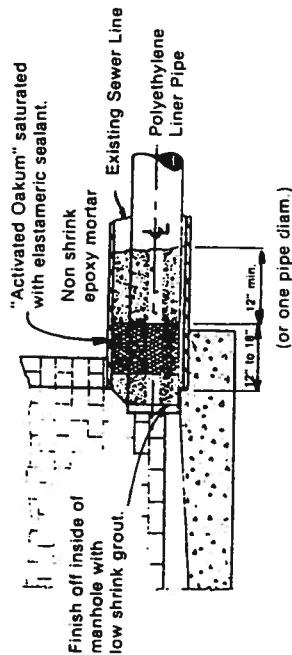


*in suitable soils the construction of a bedding and/or a foundation may not be required.

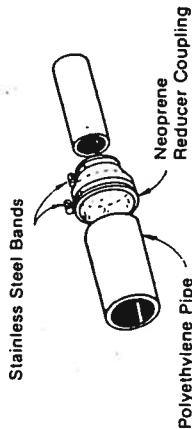
Reference: SEW RE BIL. JO. Y S... LIN... W... **PLEXCO HIGH DENSITY POLYETHYLENE PIPE**



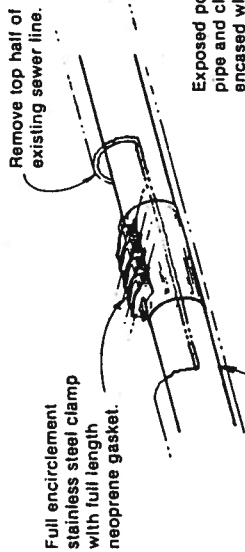
Polyethylene liner pipe being inserted in two directions from a double entrance pit, utilizing power winching equipment.



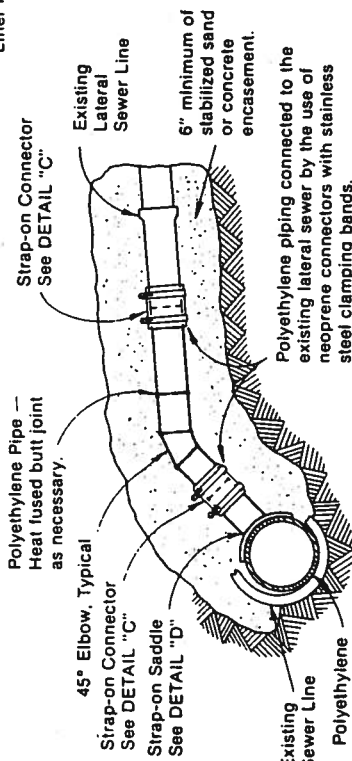
**DETAIL "A"
 SEALING PLEXCO
 POLYETHYLENE LINER
 AT MANHOLE**



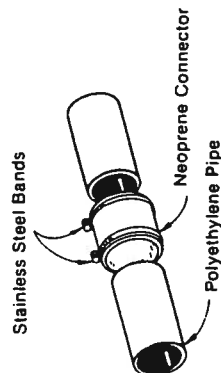
**STRAP-ON
 REDUCER COUPLING**



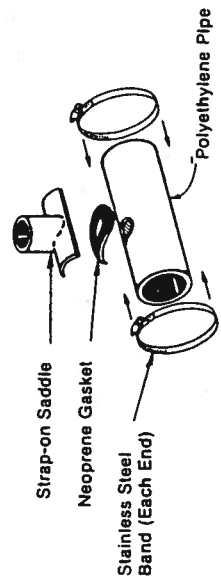
**DETAIL "B"
 ENTRANCE PIT DETAIL
 JOINING THE TERMINAL ENDS
 OF THE PLEXCO POLYETHYLENE
 LINER PIPE TOGETHER
 IN THE TWO DIRECTION
 INSERTION PIT**



**HOUSE SERVICE
 CONNECTION DETAIL**



**DETAIL "C"
 STRAP-ON
 CONNECTOR FITTING**



**DETAIL "D"
 LATERAL STRAP-ON
 SADDLE**

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Fluid Flows

Gravity flow pipelines are generally sized for flow capacity by the Manning formula:

$$Q = \left[\frac{1.486}{n} \right] \times A \times R_n^{2/3} \times S^{1/2}$$

where Q = Flow (ft.³/sec.)
 n = Manning Roughness Coefficient
 A = Pipe Flow Area (ft.²)
 R_n = Hydraulic Radius (ft.)*
 S = Slope (ft./ft.)

*For sewers flowing full or exactly half-full
 R_n = D/4 where D is the interior diameter.

The inside surface of PLEXCO EHMW PE 3408 high density polyethylene pipe is both hydraulically smooth, and water repellent. The resulting Manning Roughness Coefficient, n, is equal to 0.009. This compares to n = 0.013 for new clay tile pipe, and n = 0.015 for new concrete pipe. After operating for several years, rehabilitated sewer systems appear to stabilize at n = 0.011.

The lower flow resistance of PLEXCO EHMW PE 3408 high density polyethylene pipe helps to compensate for any reduction in flow area as a result of the smaller diameter liner and often results in the rehabilitated sewer having a flow capacity nearly equal to the original line. Table 3 presents approximate flow equivalences for various liner sizes.

Pressure flows of water-like fluids may be described by the Hazen-Williams formula:

$$h_f = 0.2083 \times \left[\frac{100 \times Q}{C} \right]^{1.852} \left[\frac{1}{D} \right]^{4.8655}$$

where h_f = Frictional loss (ft./100 ft. of pipe)
 C = Roughness Coefficient
 Q = Flow (U.S. gal./min.)
 D = Inside diameter of pipe (in.)

Values for C range from 150 to 160 with 150 recommended for a conservative design basis. For forced sewage applications, C = 130 is recommended.

In Moody chart applications, data for "smooth pipe" are recommended.

Table 3. Comparative Flows for Slipliners

Existing Sewer Inside Dia (in.)	Liner OD Actual (in.)	SDR 32.4			SDR 21			SDR 11			SDR 7		
		Min. Wall (in.)	% Flow Concrete	% Flow Clay	Min. Wall (in.)	% Flow Concrete	% Flow Clay	Min. Wall (in.)	% Flow Concrete	% Flow Clay	Min. Wall (in.)	% Flow Concrete	% Flow Clay
4	3.500							0.167	88	76	0.206	82	71
6	4.500							0.214	58	50	0.265	54	47
6	5.375	0.165	104	90	0.207	99	86	0.256	94	81	0.316	87	76
8	6.625	0.204	84	73	0.255	80	70	0.315	76	66	0.390	71	61
8	7.125	0.219	102	89	0.274	98	85	0.339	92	80	0.419	86	74
10	8.625	0.265	94	81	0.332	90	78	0.411	85	73	0.507	79	68
12	10.750	0.331	104	90	0.413	99	86	0.512	94	81	0.632	87	76
15	12.750	0.392	90	78	0.490	86	75	0.607	81	71	0.750	76	66
15	13.375	0.412	103	89	0.514	98	85	0.637	92	80	0.787	86	75
16	14.000	0.431	98	85	0.538	93	81	0.667	88	76	0.824	82	71
18	16.000	0.492	102	88	0.615	97	84	0.762	92	79	0.941	85	74
21	18.000	0.554	92	80	0.692	88	76	0.857	83	72	1.059	77	67
24	20.000	0.615	86	74	0.769	82	71	0.952	77	67	1.176	72	62
24	22.000	0.677	110	96	0.846	105	91	1.048	100	86	1.294	93	80
27	24.000	0.738	102	88	0.923	97	84	1.143	92	79	1.412	85	74
30	28.000	0.862	116	100	1.077	111	96	1.333	104	90	1.647	97	84
36	32.000	0.985	102	88	1.231	97	84	1.524	92	79	1.882	85	74
36	34.000	1.046	120	104	1.308	114	99	1.619	108	93	2.000	100	87
42	36.000	1.108	92	80	1.385	88	76	1.714	83	72	2.118	77	67

Flow % = Qp/Qc x 100; n = .009 for PLEXCO EHMW PE 3408; n = .015 for new concrete, n = .013 for new clay

Extra High Molecular Weight
High Density Polyethylene PE3408
Industrial Piping System

PLEXCO®



Application Note No. 8

System Testing

Pressure Testing Outside the Trench

If specified by the engineer, pressure testing may be conducted prior to pipe installation. After the pipe has been joined, it should be filled with water, taking care to bleed off any trapped air. It should then be subjected to a hydrostatic test pressure of a maximum of 1.5 times the system design pressure, for a maximum period of three (3) hours. During this time, the pipe is maintained at the test pressure by the periodic addition of make-up water to compensate for the initial stretching of the pipe. The line pressure-tightness is determined by visual examination. It is not necessary, therefore, to keep track of the make-up water. Every fused joint should be examined and any joint that shows any leakage must be repaired and then retested.

WARNING: Do not proceed with hydrostatic pressure tests above ground unless the construction supervisor has taken appropriate safety precautions.

Pressure Testing in the Trench

After the pipeline has been laid, it should be filled with water, taking care to bleed off any trapped air. It should then be subjected to a hydrostatic pressure test, with a test pressure at the lowest elevation to the system, that is a maximum of 1.5 times the system design pressure. When, in the opinion of the engineer, local conditions require that the trenches be backfilled immediately after the pipe has been laid, the pressure test may be made after backfilling has been completed but not sooner than that time which will allow sufficient curing of any concrete that may have been used (typical minimum concrete cure times are 36 hours for early strengths and 7 days for normal-strength materials).

The test procedure consists of two steps: the initial expansion and the test phases. To compensate for initial expansion of the pipe under test, sufficient make-up water should

be added to the system at hourly intervals for 3 hours to return to the test pressure. After the completion of this first phase (around 4 hours after initially pressurizing the pipe under test), the actual test should begin. The test phase should not exceed 3 hours. After this testing period, a measured amount of make-up water should be added to return to the test pressure. The amount of make-up water shall not exceed the allowance given in Table 1. Alternatively, testing for leakage can be done by maintaining the test pressure over a period of 4 hours, and then dropping the pressure by 10 psi. If the pressure remains steady (within 5% of the target value) for an hour, no leakage in the system is indicated.

WARNING: Under no circumstances shall the total time under test exceed eight (8) hours at 1.5 times the pressure rating. If the test is not completed due to leakage, equipment failure, etc., the test section shall be permitted to "relax" for eight (8) hours prior to the next testing sequence.

**TABLE 1 - ALLOWANCE FOR EXPANSION
UNDER TEST PRESSURE***

Allowance for Expansion (U.S. Gal/100 Ft. of Pipe)			
Nominal Pipe Size (In.)	1-Hour Test	2-Hour Test	3-Hour Test
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.5
10	0.75	1.3	2.1
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
20	2.8	5.5	8.0
22	3.5	7.0	10.5
24	4.5	8.9	13.3
26	5.0	10.0	15.0
28	5.5	11.1	16.8
30	6.3	12.7	19.2
32	7.0	14.3	21.5
34	8.0	16.2	24.3
36	9.0	18.0	27.0

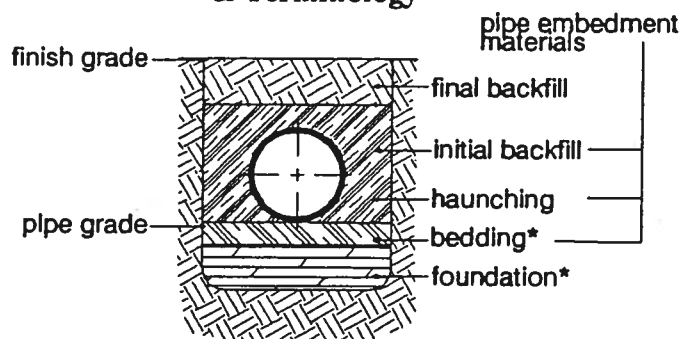
*These allowances apply only to the test period and not to the initial expansion phase.

Pipe Embedment and Final Backfilling

Pipe embedment and final backfilling should be carried out so that each zone indicated in Figure 1 is in accordance with the recommendations given herein or as specified by the engineer.

Unless otherwise specified by the engineer, the haunching and initial backfilling should be performed before the leakage test (see Application Note No. 8). The backfilling should be completed following a satisfactory test. In all cases, the haunching and initial backfill material should be placed and compacted to provide support as specified by the engineer.

**Figure 1 - Trench Construction
& Terminology**



**in suitable soils the construction of a bedding and/or a foundation may not be required.*

Soils for Pipe Embedment

To achieve a satisfactory installation of polyethylene pipe, it is essential to embed the pipe with bedding, haunching, and initial backfill materials (see Figure 1) of characteristics that provide stable and permanent support to the pipe. Soils have been grouped into five broad classes according to their suitability as embedment materials. This grouping, with descriptions of soil type (GW, GP, etc.) as per ASTM D-2487, "Standard Method for Classification of Soils for Engineering Purposes," is:

Class I - Angular crushed stone, maximum size of particle, 40mm (ca. 1-1/2 inches), including materials of regional significance such as marl, coral, crushed shells, cinders, and slag.

Class II - Naturally occurring gravels and coarse sands, containing minimum fines, maximum size of particles 1-1/2 inches, and non-cohesive when wet or dry. These include soil types GW, GP, SW, and SP.

Class III - Naturally occurring fine sands, and mixtures of gravel-clay or sandy clay, including soil types GM, GC, SM, and SC.

Class IV - Very fine soils such as silt, silty-clay, lean clay, and organic clays having a liquid limit of less than 50%, including soil types ML, CL, and OL.

Other soils, such as clays of high plasticity, or having a liquid limit of more than 50%, or containing such a high organic content as soil types MH, CH, OH, or PT are not categorized by the preceding classification system as they are not recommended for bedding, haunching, or initial backfill. If their use is unavoidable, expert engineering guidance should be obtained as to how they should be used and what additional supporting structures may be required.

Class I and II materials should preferably be used for bedding (if required), haunching, and initial backfill. For 6" and smaller pressure pipes, maximum particle size should be 1/2". Care should be taken to insure that haunching material is well placed under the haunches of the pipe and that, in the process, the pipe is not disturbed. The initial backfill should be placed in 6" layers and extend to at least 6" above the top of the pipe. Pipe embedment materials should be compacted as specified by the design engineer.

Class III materials may also be used in the embedment zone. When so used they should be compacted as specified by the engineer, which generally will be to not less than 80% Proctor density as determined by the AASHTO Method T99 for compaction and density of soils. This may normally be accomplished by walking on soil placed in 6-inch layers or by hand-tamping same with wooden tampers.

Class IV materials should be used only with the specific approval of the engineer who will determine their acceptability, depending on the ease of placement and compaction of the particular materials under consideration.

Final Backfill

General - The final backfill, unless otherwise specified, may consist of the excavated material provided it is free of unsuitable matter, such as lumps of clay, stones, construction debris, boulders, (stones over 8 inches in their longest dimension) and frozen clods.

Final Backfill Under Roads - Trenches in the right-of-way of a road should be backfilled to finished grade with an approved granular material to a compaction density of 95% or as specified by the engineer.

PLEXCO®



BULLETIN NO. 301

Extra High Molecular Weight, High Density Polyethylene PE 3408 Industrial Piping System

PLEXCO Industrial Piping products are produced from PE 3408 pipe grade polyethylene resins which meet the engineering requirements for industrial applications which require physical properties and performance criteria in excess of polyethylene pipe grade resins utilized in less demanding applications.

Polyethylene pressure pipe is defined by ASTM standards (D3035 and F714) and is produced to the following SDR/DR's which are the ANSI Preferred Number Series for O.D. (outside diameter) controlled pipe: SDR 7.3, 9, 11, 13.5, 17, 21, 26 and 32.5.

$$DR = \frac{\text{Pipe O.D. (inches)}}{\text{Minimum Pipe Wall Thickness (inches)}}$$

The Long Term Hydrostatic Strength of PLEXCO PE 3408 polyethylene pipe is 1600 psi. at 73.4°F, using water as the test medium (see PLEXCO Application Note No. 6 – Chemical and Environmental Considerations).

All pipe sizes with the same DR and Long Term Hydrostatic Strength will have equal operating pressure capability. (See opposite side.)

Packaging Data

SILO PACK is a vertical stack of coils strapped to a nonreturnable pallet.

BULK PACK is a rectangular bundle of straight lengths of pipe secured with wood members and strapping.

STRIP LOAD are layers of single lengths separated by stripping material.

TRUCKLOAD
QUANTITIES – Figures represent maximum footages per truckload per pipe size. Truckload weights would vary based on pipe walls.

Coils					Silo Packs		Truckloads	
NOMINAL PIPE SIZE	FEET PER COIL	COIL O.D.	COIL I.D.	COIL WIDTH	COILS PER PACK	FEET PER PACK	NO. SILO PACKS	TOTAL FOOTAGE
1½" IPS	500	76"	48"	8"	10	5000	6	30,000
2" IPS	500	78"	51"	13"	7	3500	6	21,000
	1500	78"	48"	40"	2	3000	6	18,000
3" IPS	500	96"	70"	25"	4	2000	5	10,000
	1000	96"	70"	46"	2	2000	5	10,000

Straight Lengths		Bulk Packs			Truckloads	
NOMINAL PIPE SIZE	FEET PER LENGTH	LENGTHS PER PACK	FEET PER PACK	BULK PACK DIMENSIONS	NO. BULK PACKS	TOTAL FOOTAGE
2" IPS	40	99	3960	43" x 17" x 40'	12	47,520
3" IPS	40	46	1840	45" x 17" x 40'	8	22,080
4" IPS	40	29	1160	48" x 17" x 40'	12	13,920
6" IPS	40	28	1120	43" x 34" x 40'	6	6,720
8" IPS	40	9	360	46" x 21" x 40'	10	3,600
10" IPS	40	11	440	46" x 34" x 40'	6	2,640

Straight Lengths		Strip Loads		Straight Lengths		Strip Loads	
NOMINAL PIPE SIZE	FEET PER LENGTH	LENGTHS PER TRUCKLOAD	TOTAL FOOTAGE	NOMINAL PIPE SIZE	FEET PER LENGTH	LENGTHS PER TRUCKLOAD	TOTAL FOOTAGE
8" IPS	40	110	4,400	22" IPS	40	16	640
10" IPS	40	64	2,560	24" IPS	40	16	640
12" IPS	40	49	1,960	26" IPS	40	9	360
14" IPS	40	36	1,440	28" IPS	40	9	360
16" IPS	40	30	1,200	30" IPS	40	9	360
18" IPS	40	25	1,000	32" IPS	40	9	360
20" IPS	40	16	640	36" IPS	40	6	240

PLEXCO can produce pipe lengths up to 50'. Check with your PLEXCO sales offices for availability for other lengths.

PLEXCO[®]



Key Features of Butt Fusion Procedures

PLEXCO PE 3408 EHMW High Density Polyethylene Pipe is joined by a simple heat fusion process. The basic steps in this process are:

1. Be sure that the surfaces of the fusion tools, pipe and fittings are free of contaminants.
2. Heat the surfaces to be joined — both the pipe and fittings — simultaneously at a prescribed temperature for a specified time.
3. Remove the heater — bring melted surfaces together.
4. Hold until solidified.

The fusion produces a joint that is as strong as the pipe itself and has a record of proven performance.

Before you begin fusing, here are some points to remember:

1. All heater surfaces have a thin layer of non-stick coating that is easily scratched or scraped off. This coating prevents melted polyethylene from adhering firmly to the heater surfaces, but occasionally it also must be cleaned.

Metal tools should NEVER be used to clean the heater surfaces because they scratch and remove the coating.

Wooden implements and clean, dry, lint-free rags are recommended for cleaning. All-cotton rags are recommended because rags containing a substantial amount of synthetic fibers may melt and char against the heater surface.

If the non-stick coating becomes worn or scratched, the heating unit should be recoated.

Melted polyethylene adheres firmly to the heating iron and is more difficult to remove at places where the coating has been scraped off. In addition, since the coating acts as an insulator, heat transfer in these uncoated areas is greater, and local overheating can occur.

2. Just before using, wipe heaters to remove dirt and foreign material. As soon as possible after use, clean heaters with wooden implements and clean rags to remove melted or charred plastic.

3. At the end of every heating cycle, quickly observe the parts to be joined to insure sufficient and uniform melting patterns.

Join parts within 3 seconds.

If a non-uniform pattern is obtained, allow the pipe to cool, cut off the pipe ends, and repeat the procedure.

4. Check heater surface temperature at least once a day with a surface pyrometer or crayon indicators for $440 \pm 10^{\circ}\text{F}$ or $500 \pm 10^{\circ}\text{F}$ fusion surface temperature. The heater thermometer will probably read a higher temperature than the fusion surfaces. Check the thermometer frequently for consistent readings.

5. NEVER lay a hot heating unit on the soil or grass when the heat cycle is completed.

Return it to the holder, if possible, or at least lay it on a board.

Soil can contaminate the joint and damage the coating; grass may burn and char on the heater surface.

Temperature for Butt Fusion

PLEXCO Technical Services personnel have conducted extensive testing to qualify the butt fusion procedure under laboratory conditions at a number of different temperatures over the range of 350° to 525°F . This work has shown that there are a number of "time-temperature-pressure" conditions that can be used to make acceptable joints.

The laboratory proven procedures have been modified based on field experience to provide two heater iron surface temperatures that are recommended for butt fusion of PLEXCO Polyethylene Pipe and Fittings: 440°F and 500°F . The choice of temperature should be based on the operating procedures and operating conditions of the individual installer.

The principal difference in the procedures used for 440°F and 500°F is the heating time necessary before making a joint. The lower temperature requires a slightly longer heating time. This extra time does allow some advantages in control and reproducibility of bead size. For this reason, PLEXCO recommends 440°F as the preferred heating iron surface temperature for fusing PLEXCO PE 3408 EHMW Pipe and Fittings.

PLEXCO®



Butt Fusion Procedure

With a clean rag, wipe both inside and outside surfaces of the two ends to be joined to remove dirt and foreign material. It is important that the ends protruding past the jaws be absolutely clean and free of contaminants.

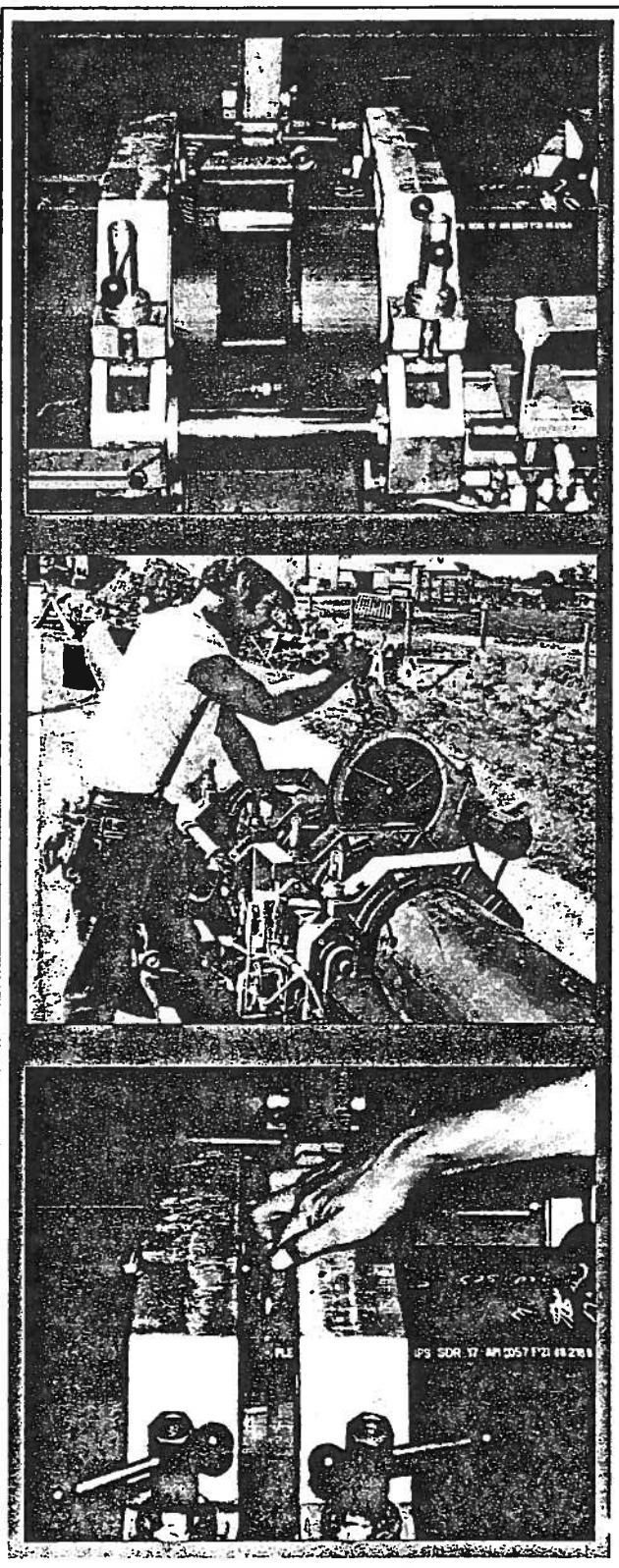
1. Install pipe in machine, allowing pipe ends to protrude 1" - 2" past face of jaw.

2. Slide facer so that it can be placed between pipe ends. Use caution to avoid coming in contact with pipe. Cut pipe until the stops on each side of the facer are against the clamp bushings at the front and rear. An increase in the facer motor speed will occur as the cutting load is reduced. Separate the two pipe ends by opening pipe jaws, turn off motor, and move facing unit to storage position. **DO NOT** touch the newly faced surfaces with the hands, as perspiration or body oils could contaminate the joint area, resulting in a weakened fusion.

IMPORTANT: The ends are properly faced when **BOTH** stationary and movable clamps are against the stops on each side of the facing unit. This will insure smooth, square pipe ends that will match perfectly when fusing.

3. Bring the two pipe sections together and, with the fingers, feel for any high-low difference at the junction of the two ends. If necessary, tighten the appropriate inside clamp until the two sections are aligned as closely as possible.

IMPORTANT: After facing pipe ends, if any adjustment at all is made on one or both inside clamps, then the facing unit should be re-installed and the pipe ends given several turns with the cutter until the motor speeds up, before continuing with heating and fusing.



Butt Fusion Procedure

Butt fusion of PLEXCO PE 3408 EHMW High Density Polyethylene Pipe and Fittings is easily performed utilizing the equipment available today. For pipe sizes 4" IPS and larger, hydraulic fusion machines are normally used, and the following procedures are presented for such machines. Pipe sizes of 4" IPS and smaller are fused using manually operated equipment. The procedures and principles for manual fusion equipment are essentially the same as those which follow.

Fusing PLEXCO PE 3408 Pipe to Other Manufacturers' Pipe

Industry studies indicate that polyethylene of different trade names and/or different polyethylenes, such as 2306, 2406, 3406, and 3408 materials, can be successfully joined by heat fusion.

Melt times prescribed at 500° F by each manufacturer for his product should be used. Apply the heating tool first to the material requiring the longest melt time. Then apply the product requiring the lesser melt time to the heater so the melt cycle for both products will be completed at the same time. All other fusion conditions and procedures remain the same as when joining PLEXCO products.

The Plastics Pipe Institute has issued a document, PPI Technical Note TN-13, on "General Guidelines for the Heat Fusion of Unlike Polyethylene Pipes and Fittings." PLEXCO recommends that these guidelines be utilized when joining different polyethylenes. However, the mixing of different polyethylenes should not be done indiscriminately — optimum conditions will be achieved when joining pipe and fittings from the same manufacturer's system.

Upon request, PLEXCO will provide additional information and technical assistance in proper fusion procedures for joining the PLEXCO system with polyethylene systems of other manufactures and material designations.

Preparation Procedure for Hydraulic Fusion Machines

1. Check oil level in reservoir. If necessary add oil as recommended by the equipment manufacturer.

For units powered by electric motors:

- 2A. (a) Plug in heater electrical cord.
(b) Plug facer electrical cord into outlet.
(c) Plug in hydraulic pump motor cord and turn on.

For units powered by self-contained gasoline engines:

- 2B. (a) Fill tank with gasoline.
(b) Disconnect heater plug and open facer operating valve.
(c) Close choke, turn on switch, and press starter button.
(d) Open choke as engine warms, close facer operating valve, and plug in heater.

3. Place heater in heater box.

4. Check hydraulic pressure gauge and adjust pressure according to pipe size as recommended by PLEXCO's Technical Service Department.

5. Set up outboard pipe roller supports and/or trailer pipe support and adjust to proper height.

6. If necessary, install appropriate inserts in clamps.

7. Check heater temperature. Clean heater with wooden implements or rags. Do not use metal tools since these will scratch and remove the non-stick coating. If necessary, adjust to maintain recommended fusion surface temperature range of $440^{\circ} \pm 10^{\circ}\text{F}$. An alternate temperature of $500^{\circ} \pm 10^{\circ}\text{F}$ may be used.

PULSE INPUT MODULE (PIM)

A 10-channel multi-mode pulse input module, designed to sense either dry contact closures or voltage signals. Designed to operate in the following modes: status, pulse accumulator, pulse incremental count, time-interval, and sequence-of-events.

Output Module Types:

RELAY OUTPUT (RLO)

A 6-channel relay output module, providing isolated Form C output contacts with logic verification.

ANALOG OUTPUT (ANO)

A 6-channel analog output module, providing 0-10V and 4-20mA outputs per channel.

REMOTE AREA NETWORK (RAN)

The RAN refers to the general and comprehensive strategy for providing cost-effective long-range connectivity between System 2300 components in both plant and field environments. This strategy is implemented by way of hardware and software capabilities designed into all Geomation 2350 Series MCUs and NRUs.

Data Link Options:

The Geomation RAN network allows the user to select any appropriate mix of data link options within a single network.

HARDWARE

2350 Series Remote Units (MCUs and NRUs) can be connected together on a simple multi-drop cable pair which can extend thousands of feet without repeaters. Remote units are interconnected in this manner in locations where it is practical to install a low-cost cable pair between Remotes.

RADIOS

MCUs and NRUs can be linked by radio, extending the measurement and control network into locations where it is impractical to install communication cables. The radio link is a standard option for each remote unit. Radio options are factory installed if originally purchased with the MCU or NRU. Alternatively, they can be field installed to accommodate changes in the network configuration.

FIBER OPTICS

Communications hardware and software flexibilities in 2350 Series Remote Units will also support point-to-point fiber optic data links. This optional capability is useful if fiber optic communication facilities already exist or if even higher common-mode isolation were required between nodes in the network.

PUBLIC TELEPHONE NETWORK

Further flexibility of network design is accommodated by permitting the possibility of node-to-node communication using the public telephone network. MCUs and NRUs support the use of optional low power auto-dial/auto-answer modems within the RAN. One utility of this feature permits locating a Network Monitor Station in an office many miles distant from a remote MCU or a remote measurement and control network. The expansion of cellular telephone services throughout the U.S. further enhance the usefulness of dial-up networks from remote areas.

General Network Features:

The Geomation RAN network was designed for simplicity, enabling the use of low-cost communication facilities within the standard product. The standardization results in higher reliability and permits user installation and reconfiguration of a System 2300.

BANDWIDTH CHARACTERISTICS

Two fundamental design goals determine the communication rates supported on the RAN1 and RAN2 ports of 2350 Series Remote Units. One goal is the support of low-cost voice band radio links, and the other is to minimize the total communications power consumption.

RAN1 and RAN2 ports:

Data Rate: 1200 baud

Signalling: CCITT V.23, half duplex

Supported links: hardwire or radio

Isolation: balanced line, transformer coupled

In addition to the RAN1 and RAN2 low-power built-in modem ports, there are two other standard communication ports on 2350 Series Remote Units: EIA1 and EIA2. While these ports can support other purposes, such as connection of Personal Computer Workstations and external instruments, they can also operate as RAN ports for node-to-node communications at high data rates.

EIA1 and EIA2 ports:

Data Rate: to 19.2K baud

Signalling: digital, RS-232C, full duplex

Supported links: fiber optic and public telephone network modem

NETWORK SIZE

The RAN supports an addressability range of 65,536. However, the size of the network is a function of the more practical matter of the message traffic on the network. The amount of message traffic is determined by user or applications programming of MCUs as much or more than it depends on how many Remote Units exist in a particular network. Intelligence in the MCU is used to summarize and analyze data, and to execute control decisions locally at the MCU, thus reducing the extensive message traffic typical of host-driven SCADA systems. For more detail relating to network capacity, see data sheet entitled "Remote Area Network."

Geonet Communications Protocol (GCP):

GCP is a set of communication rules implemented in 2350 Series Remote Unit Software. It is modeled after the ISO Reference Model of Open Systems Interconnection for modular communication design. GCP allows easy expansion and a virtually unlimited number of network nodes. It provides reliable, versatile, and efficient data communications over low-cost, low-power facilities by means of statistical arbitration and CRC (Cyclic Redundancy Check) error detection codes. For more detail relating to GCP, see data sheet entitled "Remote Area Network."

ENVIRONMENTAL

2350A and 2352A Remote Units:

OPERATING TEMPERATURE:

-30°C to +65°C

STORAGE TEMPERATURE:

-40°C to +70°C

RELATIVE HUMIDITY:

5% to 95% (non-condensing)

PRESSURE ALTITUDE:

Operating: 15,000 Feet

Storage: 50,000 Feet

2350B and 2352B Remote Units:

OPERATING TEMPERATURE:

0°C to +50°C

STORAGE TEMPERATURE:

-25°C to +55°C

RELATIVE HUMIDITY:

5% to 95% (non-condensing)

PRESSURE ALTITUDE:

Operating: 15,000 Feet

Storage: 50,000 Feet

2310 Network Monitor Station:

OPERATING TEMPERATURE:

+5° C to +40° C

STORAGE TEMPERATURE:

-40° C to +70° C

RELATIVE HUMIDITY:

15% to 80% (non-condensing)

PRESSURE ALTITUDE:

Operating: 15,000 Feet

Non-Operating: 50,000 Feet

2320 Portable Network Monitor:

OPERATING TEMPERATURE:

0° C to +40° C

STORAGE TEMPERATURE:

-20° C to +65° C

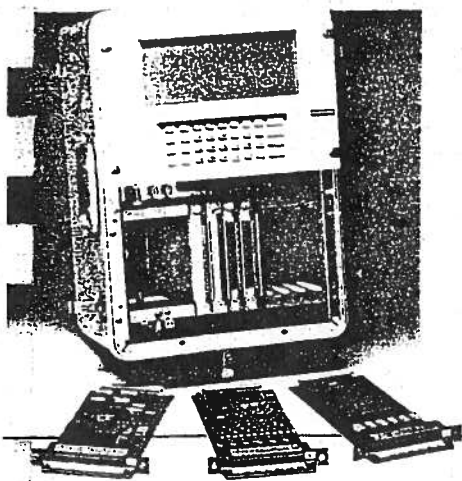
RELATIVE HUMIDITY:

20% to 80% (including condensing)

PRESSURE ALTITUDE:

Operating: 15,000 Feet

Non-Operating: 50,000 Feet



Features designed to benefit the user, his patience and his pocketbook.

The System 2300 is set up to be the most flexible of its kind. Thanks to the standardization and modularity of hardware, software, and microprocessor control, and the effective use of distributed intelligence, it is the easiest system of its kind to purchase, program, use, alter, expand, or appreciate.

And it's designed to stay that way. Military and industrial grade CMOS circuitry with positive gold-contact pin-and-socket connections makes it rugged enough for the harshest environments. It tolerates abnormally wide temperature extremes as well as vibration environments. So it can be pole-mounted, buried in a standard irrigation control box, or wall-mounted in EMA enclosures, even installed at compressor stations or on board ships.

Designed for environmental compatibility.

Remote Units' adaptive power consumption allows each one to minimize the power it uses. Power-conserving alarm clock circuitry allows any unit to be made dormant while no activity has been programmed at the user.

Plus, battery power provides the added benefit of uninterruptable power. And solar charging allows installation in any remote environment, regardless of the availability of local power.

And specially-designed circuits and grounding techniques protect all units against static electricity discharge and ground potential surges.

The most logical, low-risk solution to remote measurement and control.

The Geomation System 2300 represents a low-risk opportunity for any company considering automated remote measurement and control. Especially when the advantages of cost efficiency—in installation, use, and expansion—are figured in with its exceptional performance.

No other system does so much so easily, for so little.

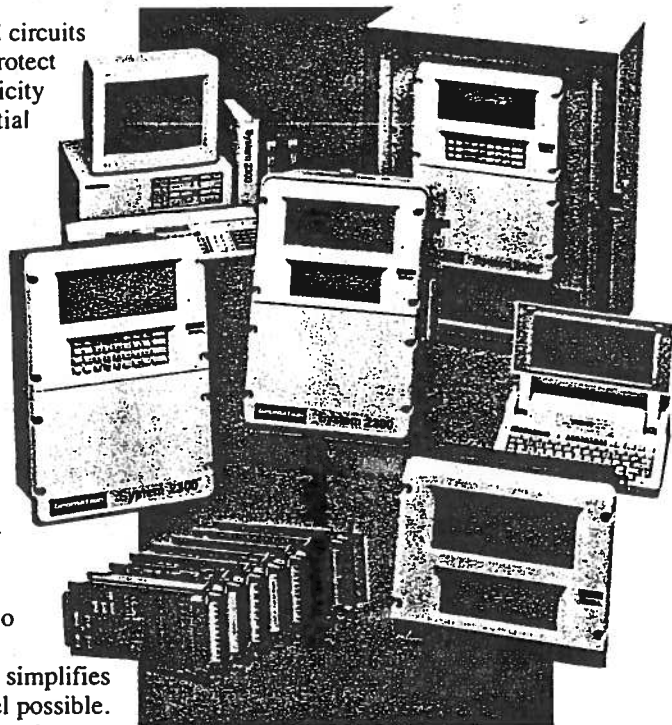
Menu-driven operation simplifies user input to the easiest level possible.

Standardized hardware and software maximizes reliability while minimizing cost.

Measurement performance is unequalled in terms of range, resolution, stability and accuracy.

And functional flexibility enables one system to automate an entire spectrum of remote measurement or control tasks.

This most advanced evolution of distributed intelligence SCADA architecture does away with costly and time-consuming custom engineering, awkward and expensive system upgrades, costly high bandwidth



communications facilities, and expensive host computers.

For field installations large or small, there simply isn't another system that addresses the needs of automated measurement and control with as much accuracy, flexibility and cost-efficiency as a Geomation System 2300.

Geomation, Inc.
15000 West Sixth Avenue
Golden, Colorado 80401

(303) 278-2350
FAX: (303) 279-1029



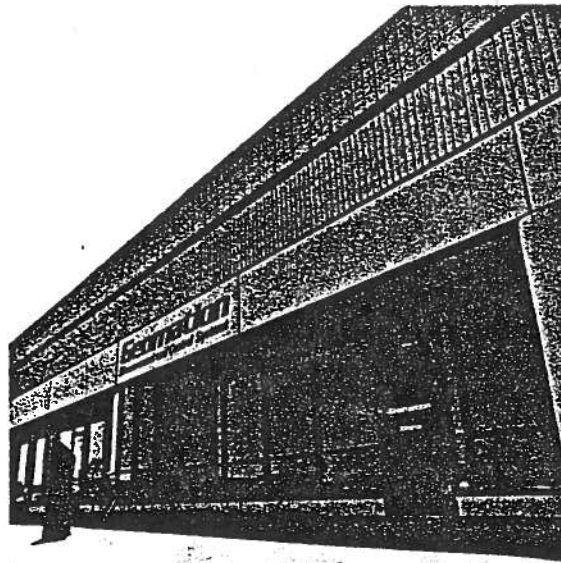
COMPANY BACKGROUND

Geomation was founded as a Colorado corporation in February of 1982, to provide automated data acquisition strategies for geotechnical measurements. However, while initially providing design and system integration services, it soon became clear that remote environment automation required fundamental innovation in order to make a substantial contribution to market needs.

The Geomation System 2300 is the result of a comprehensive product plan and a substantial R&D program to meet the challenging diversity of requirements for automation in the remote environment. The 2300 is an expanding family of standard product capabilities providing total system solutions.

Going beyond geotechnical automation, Geomation today offers measurement and control solutions for the water and power industries, ranging from structural behavior monitoring of dams to the control of irrigation water delivery systems, and from the remote control of hydroelectric generating plants to the metering and control of electric power substations.

Geomation is an independent, closely held company that has been financed from its inception by its founders and a group of private investors.




dBASE III PLUS™ is a registered trademark of Ashton-Tate, Inc.

GEOBUS,™ GEONET,™ and RAN™ are trademarks of Geomation, Inc.

1-2-3™ is a registered trademark of Lotus Development Corporation.

MS™.DOS is a registered trademark of Microsoft Corporation.

WELL LEVEL TRANSMITTERS, LT-101, 201, 301

 Woodward-Clyde Consultants LEVEL TRANSMITTERS LT 101 LT 201 LT 301			LEVEL INSTRUMENTS				SHEET <u>1</u> OF <u>1</u>	
			NO	BY	DATE	REVISION	SPEC. NO.	REV.
							CONTRACT	DATE
							REQ. - P.O.	
							BY	CHK'D
GENERAL	1	Tag Number	LT 101	LT 201	LT 202			
	2	Service	water	water	water			
	3	Line No./Vessel No.	RW-1	RW-2	RW-3			
	4	Application	well level	well level	well level			
	5	Function	pump control	pump control	pump control			
	6	Fail-Safe	NA	NA	NA			
PROBE	7	Model Number	591	591	591			
	8	Orientation	Vertical	Vertical	Vertical			
	9	Style	pressure	pressure	pressure			
	10	Material	316 SS	316 SS	316 SS			
	11	Sheath	Teflon	Teflon	Teflon			
	12	Insertion Length	1 ft	1 ft	1 ft			
	13	Inactive Length	NA	NA	NA			
	14	Gland Size & Mat'l.	NA	NA	NA			
	15							
	16	Conduit Connection	3/4" NPT	3/4" NPT	3/4" NPT			
AMPLIFIER	17	Location	NA	NA	NA			
	18	Enclosure	NEMA 4	NEMA 4	NEMA 4			
	19	Conduit Connection	3/4" NPT	3/4" NPT	3/4" NPT			
	20	Power Supply	12 VDC	NA	NA			
SWITCH	21	Type	NA	NA	NA			
	22	Quantity and Form	1	1	1			
	23	Rating: Volts/Hz or dc						
	24	Amps/Watts/HP						
	25	Load Type						
	26	Contacts Open						
	27	Close						
	28	Level						
TRANS.	29	Output	4-20 mA	4-20 mA	4-20 mA			
	30	Range	0-175 ft	0-175 ft	0-175 ft			
	31	Enclosure Class	NEMA 4	NEMA 4	NEMA 4			
OPTIONS	32	Compensation Cable	NA	NA	NA			
	33	Local Indicator						
	34	I/P Transducer						
	35	Signal Lights						
	36	Upper Fluid	Water	Water	Water			
SERVICE	37	Dielectric Constant	NA	NA	NA			
	38	Lower Fluid	NA	NA	NA			
	39	Dielectric Constant	NA	NA	NA			
	40	Pressure Max.	Normal	70 PSI	50 PSI	70 PSI	50 PSI	
	41	Temp. Max.	Normal	70°F	50°F	70°F	50°F	
	42	Moisture	NA	NA	NA			
	43	Material Buildup						
	44	Vibration						
	45	Manufacturer						
	46	Model Number						
Notes:								

TYPES 590 & 591 CABLE SUPPORTED LIQUID LEVEL TRANSMITTERS

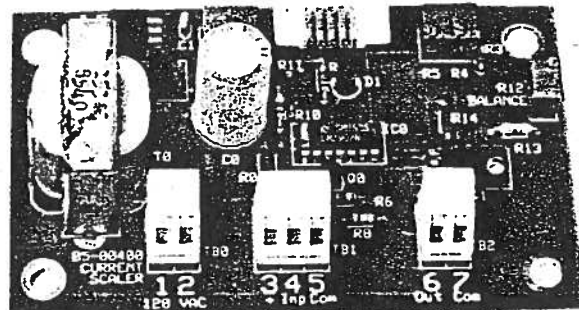
- Factory calibrated range, non-adjustable
- Optional scaling amplifier allows field recalibration of both zero and span
- Measures the liquid level in wells, bore holes, sumps, tanks, etc.
- 316 SS diaphragm sealed solid state strain gage element is state of the art
- Non-plugging, insensitive to build up
- Small, accurate, simple, reliable
- 200% minimum overpressure protection
- 2 wire 4-20 MADC signal loop powered
- Isolated body prevents ground loops
- Cable shielded against power wiring noise
- Hermetically sealed and submergeable

APPLICATION

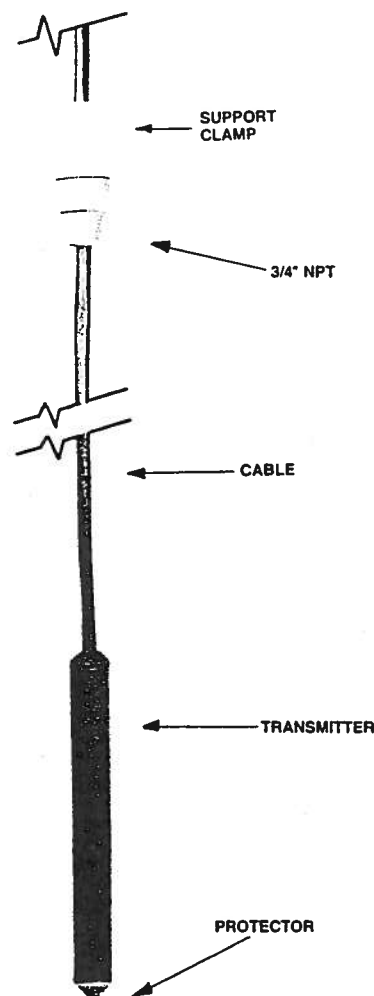
The transmitter is hung down in the fluid whose level is to be measured. It is suspended at the elevation which is to be "zero" level. This position may be changed as desired. There is no need to cut off excess cable as it does not affect the accuracy of this instrument. The pressure at the sensor face is linearly proportional to the distance to the surface of the fluid. This pressure is converted into a 4-20 milliamp signal which is equal to the fluid level. That signal is used to indicate, log, and/or control the fluid level. See Types 592 & 593 when remoted and adjustable electronics are required.

OPERATION/CONSTRUCTION

The basic measuring element is a diffused silicon strain gage bridge. The bridge output is a function of the fluid pressure at the sensor. This output is converted into a 4-20 milliamp signal. The strain gage is isolated from the fluid media by an oil filled 316 SS diaphragm. The diaphragm face is recessed in the lower end of the body tube for protection. The signal/support cable is sealed into the top end of the body tube. The electronics and cable connection are hermetically sealed in epoxy. The cable contains 2 signal wires, an atmospheric reference tube, two strengthening strands, and an overall foil shield. Note that the body tube is isolated from the signal cable shield so as to prevent ground looping.



SCALING AMPLIFIER CARD



TYPE 591-G3 WITH 3/4" NPT SUPPORT CLAMP

MODEL NUMBERING SYSTEM: (BASIC TYPE) - (SENSOR ELEMENT) - (CABLE JACKET) - (FEET OF CABLE)

BASIC SPECIFICATIONS

Sensor Body Material: 316 SS

Cable: PVC or Teflon jacket

Output Signal: 4-20 MADC, isolated and shielded

Supply Power: 12 VDC min to 40 VDC max

Max Loop Ohms: 600 @ 24 VDC; 1400 @ 40 VDC

Accuracy: Better than 0.5% of max range

Repeatability: Better than 0.1% of max range

Temperature Effect: 0.5% of maximum range per 40° F

liquid temperature change

Operating temperature: -20°F to +220°F

Barometric Effect: None, fully compensated

Overrange Effect: Insignificant up to 2 times max range

or a minimum of 85 feet total for any range

SENSOR ELEMENTS

M/N	MAX RANGE - H ₂ O		M/N	MAX RANGE - H ₂ O	
	FEET	METERS		FEET	METERS
G1	3.3	1.0	G6	100	30
G2	6.6	2.0	G7	200	60
G3	17	5.0	G8	450	135
G4	33	10	G9	1100	335
G5	66	20	G10	2200	670

CABLE JACKET

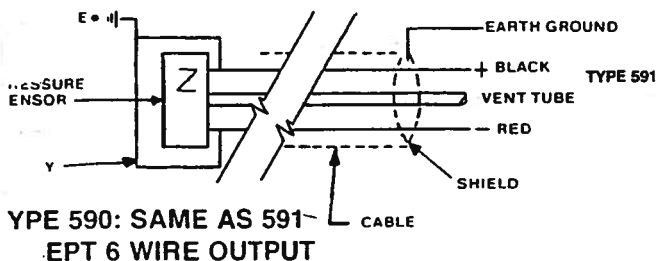
" = Polyvinyl chloride (up to 2500' long)

" = TFE Teflon (up to 100' long)

OPTIONAL VARIATIONS

- Above ground scaling amplifier: allows recalibration of zero and span values. Zero may be offset $\pm 100\%$ of max range. Span may be set for any value between 10% and 100% of max range. Unit requires power; either 120 VAC, 240 VAC, or 24 VDC.
- Type 590 transducer has the sensing bridge only with a 100 MVDC nominal output signal. It is for use with user supplied electronics.

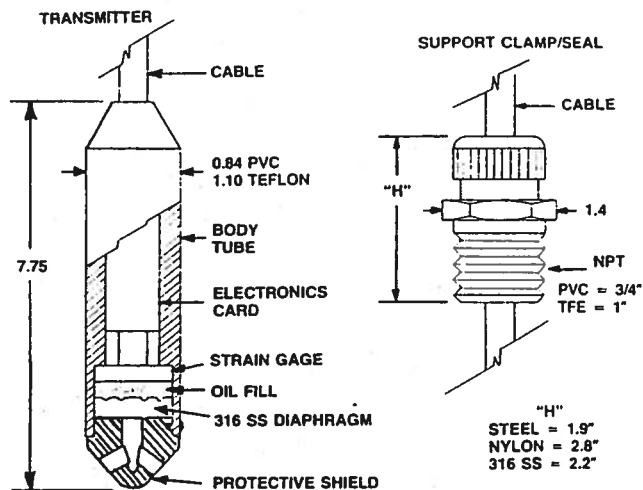
HOOKEUP SCHEMATIC



DELTA CONTROLS CORPORATION

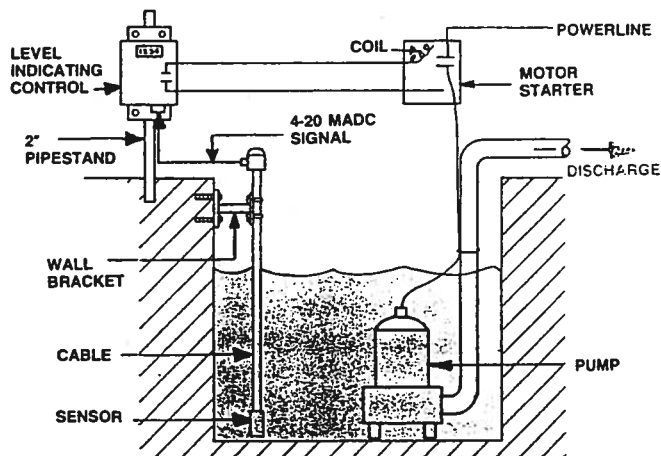
585 FORTSON STREET
SHREVEPORT, LA 71107 USA
TELEPHONE: 318-424-8471
TELEX: 784554 FAX: (318) 425-2421

DIMENSIONS

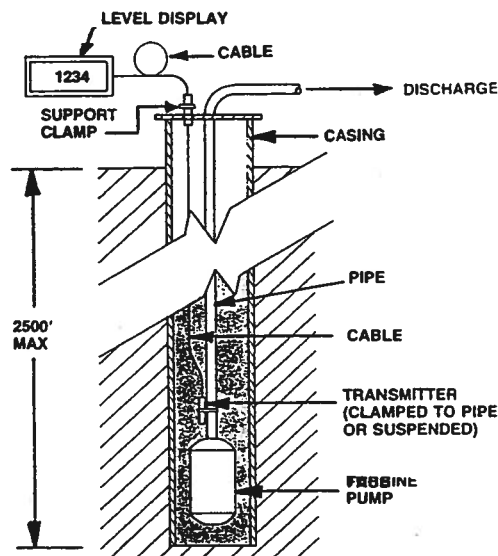


* STANDARD 4.0 MA @ 0-100% OF MAX RANGE
CALIBRATION 20.0 MA @ 40% - 100% OF MAX RANGE

SUMP PUMP CONTROL



WATER WELL LEVEL READOUT



WELL LEVEL SWITCHES, LS-102, 202, 302

<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> Woodward-Clyde Consultants <i>WELL LEVEL SWITCHES</i> <i>LS-102, LS-202, LS-302</i> </div> <table border="1" style="margin-left: 10px;"> <tr> <th colspan="4">LEVEL INSTRUMENTS (CAPACITANCE TYPE)</th> </tr> <tr> <th>NO</th> <th>BY</th> <th>DATE</th> <th>REVISION</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table> </div>			LEVEL INSTRUMENTS (CAPACITANCE TYPE)				NO	BY	DATE	REVISION																					SHEET <u>1</u> OF <u>1</u>	
			LEVEL INSTRUMENTS (CAPACITANCE TYPE)																													
NO	BY	DATE	REVISION																													
			SPEC. NO.	REV.																												
			CONTRACT	DATE																												
			REQ. - P.O.																													
			BY	CHK'D																												
			APPR.																													
GENERAL	1	Tag Number	LS-102	LS-202	LS-302																											
	2	Service	Water	Water	Water																											
	3	Line No./Vessel No.	RW-1	RW-2	RW-3																											
	4	Application	Well Level	Well Level	Well Level																											
	5	Function	low level shutdown	low level shutdown	low level shutdown																											
	6	Fail-Safe	low	low	low																											
PROBE	7	Model Number	104	104	104																											
	8	Orientation	vertical	vertical	vertical																											
	9	Style	flexible	flexible	flexible																											
	10	Material	SS	SS	SS																											
	11	Sheath	NA	NA	NA																											
	12	Insertion Length	6 inches	6 inches	6 inches																											
	13	Inactive Length	NA	NA	NA																											
	14	Gland Size & Mat'l.	NA	NA	NA																											
	15																															
	16	Conduit Connection	3/4" NPTF	3/4" NPTF	3/4" NPTF																											
AMPLIFIER	17	Location	NA	NA	NA																											
	18	Enclosure																														
	19	Conduit Connection																														
	20	Power Supply																														
SWITCH	21	Type	SPDT	SPDT	SPDT																											
	22	Quantity and Form	1 NO	1 NO	1 NO																											
	23	Rating: Volts/Hz or dc	240 AC	240 AC	240 AC																											
	24	Amps/Watts/HP	10	10	10																											
	25	Load Type																														
	26	Contacts Open	On	Incr.																												
	27	Close	Level	Decr.																												
TRANS.	28	Output	NA	NA	NA																											
	29	Range																														
OPTIONS	30	Enclosure Class																														
	31	Compensation Cable	NA																													
	32	Local Indicator																														
	33	I/P Transducer																														
	34	Signal Lights																														
SERVICE	35																															
	36	Upper Fluid	Water	Water	Water																											
	37	Dielectric Constant																														
	38	Lower Fluid																														
	39	Dielectric Constant																														
	40	Pressure Max.	Normal	70PSI	50PSI	70PSI	50PSI																									
	41	Temp. Max.	Normal	100°F	50°F	60°F	50°F	100°F	50°F																							
	42	Moisture	NA			NA																										
	43	Material Buildup																														
	44	Vibration																														
45	Manufacturer																															
46	Model Number																															
Notes:																																

TIP SENSITIVE LEVEL SWITCH

TYPE 104 PROBE STYLE CONTROL

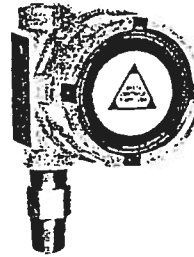
- Works on liquids, slurries, and solids
- 316 SS rod and Teflon wetted parts
- Rod or cable/weight sensing probe
- Probe length is field adjustable
- 10 Amp SPDT heavy duty output relay
- High/Low failsafe relay action selector
- F.M. plus C.S.A. listed & labeled housing
- Has a flush Teflon seal; no cavity to plug up
- O.K. up to 400°F process temperature
- Vibration resistant, no glass insulation to break or epoxy to fracture
- O.K. up to 5000 psig process pressure
- Secondary metal to metal rod seal prevents catastrophic seal leaks
- Rod seal is reliable Teflon, not fragile glass
- High reliability; 100 hour operationally tested
- Quality assured; 100% tested & inspected
- Special circuitry rejects electrical noise
- Integrating 1 second time delay standard
- Adjustable 1 to 60 second delay is optional
- Economical to acquire and to own
- In stock for immediate shipment

APPLICATION

The Type 104 probe style control switches when a conductive material touches the tip of the sensing probe. More of the sensing probe must be covered when the material is insulating and has a lower dielectric constant. The Type 104 will sense almost any sort of material, even insulators with a low density and a low dielectric constant.

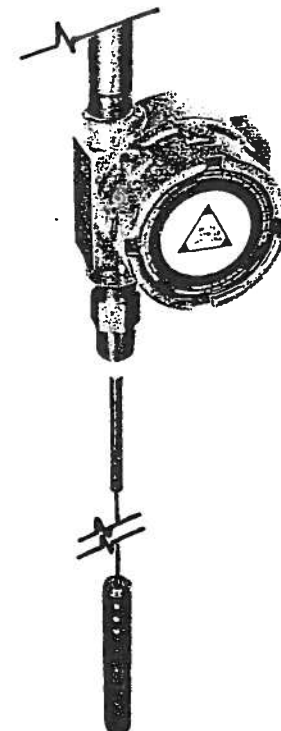
The unit is designed to detect high or low levels of liquids, slurries, and solids. It is designed for mounting on the top of a tank, container, or open pit. It is intended that the sensing probe extend down from the top to the point at which level switching is to occur. The unit can also be mounted so that its sensing probe extends in from the side of the container. This side mounting position should be limited to clean liquids and solids (knife blade probe). Slurry tanks should be entered only from the top.

The sensed material may be conductive (water, acid, caustic) or nonconductive (oil, wheat, gasoline). The dielectric constant of the material should be 2.0 or higher. All water based compounds and most medium weight hydrocarbons meet this requirement (ammonia, crude oil, Freon, fuel oil, lube grease).



TYPE 104
WITH SOLID ROD PROBE

*2566 102, 202, 302
Well low level controls*



TYPE 104
WITH FLEXIBLE CABLE PROBE

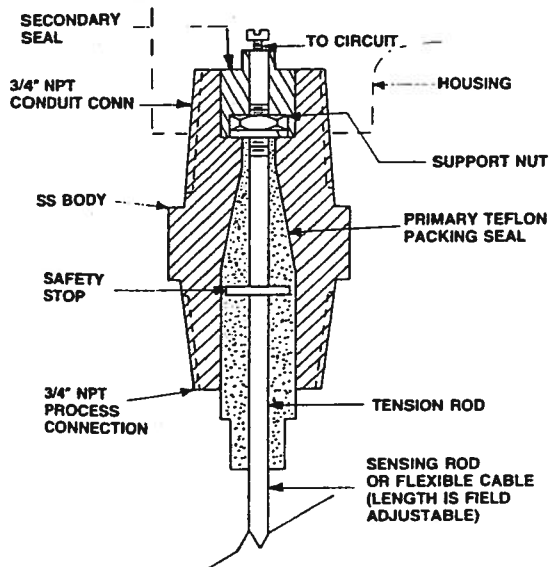
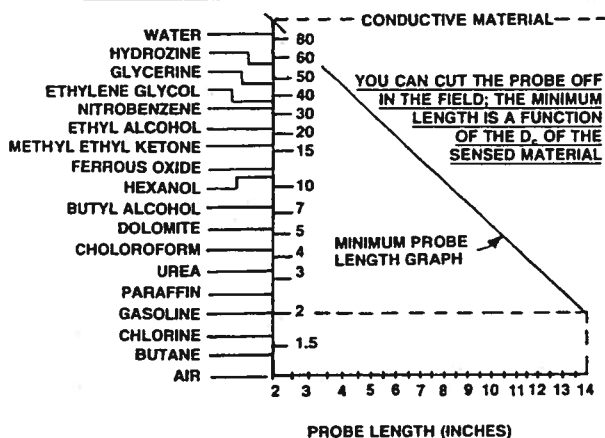
DELTA MAKES THE VERY BEST LEVEL SWITCHES

OPERATION

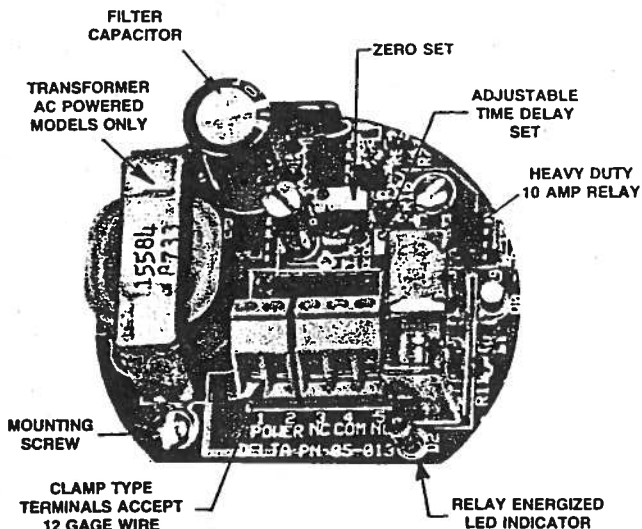
The Type 104 is insensitive to buildup on the tip of its sensing probe. The deposited buildup material can be wet, sticky, or even an insulator. Recalibration or cleaning may be required under conditions such as extreme candeling, glacial salt bridging, etc. R.F. admittance technology is the basis for this new and improved level control design. An advanced sensing method, using pulsed radio frequency waves, is the heart of this new circuit technique. This method produces the ultimate in stability, electrical noise rejection, switching accuracy, and sensitivity. False, and erroneous switching problems have essentially been eliminated in this design. High speed filtering (2000 SPS) keeps electrical spikes, line surges, broadcast R.F., etc. from affecting this control.

You select the relay action with a gold contact selector plug. The relay can be normally energized or normally deenergized as you desire.

NONCONDUCTIVE MATERIALS

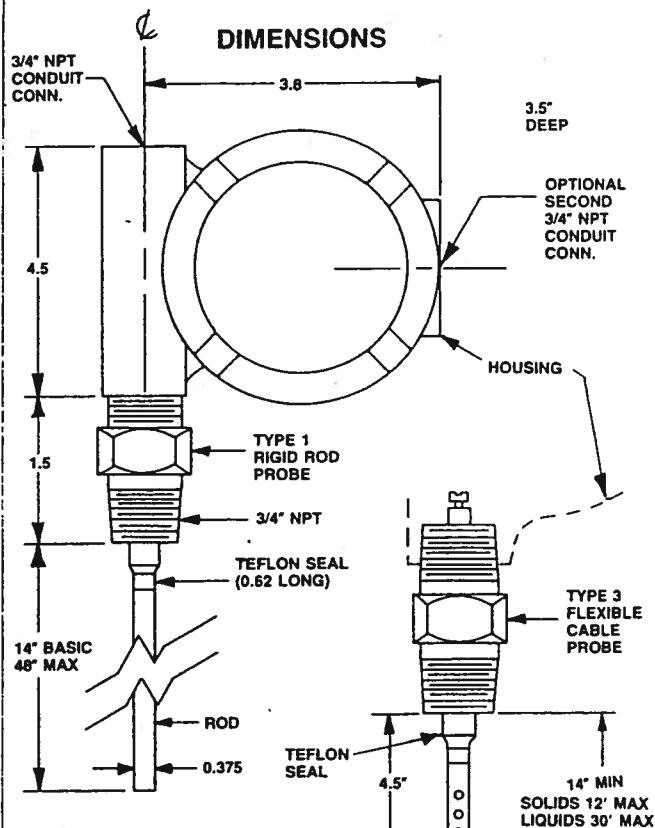


HIGH RELIABILITY SEALING GLAND DESIGN

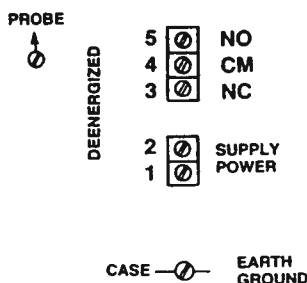


CIRCUIT BOARD ARRANGEMENT

DIMENSIONS



HOOKUP SCHEMATIC



MODEL NUMBERING SYSTEM:

(BASIC TYPE) - (SUPPLY POWER) - (RELAY STYLE) - (HOUSING RATING) - (PROBE STYLE) - (INSERTION LENGTH) - (SIZE & TYPE OF PROCESS CONN.)

BASIC MODEL: 104-A-D-N4-1-14"-3/4" NPT LEVEL SWITCH

WETTED MATERIALS: 304 SS Body; 316 SS Rod; Teflon Seal

BASIC SPECIFICATIONS

Body: 304 SS; 316 SS & others optional
Rod: 316 SS; other materials optional
Cable & Weight: 304 SS; others optional
Packing Seal: TFE Teflon plus a backup
Output: SPDT relay contacts, 10 amps @ 240 VAC
Relay Action: Failsafe position is plug selectable
Relay State: Indicated by a red LED light
Relay Speed: 1 Second integrating type time constant
Accuracy: Better than 0.1% of max range
Repeatability: Better than 0.1% of max range
Process Temperature: -20°F to 230°F basic
Temperature Effect: 0.3% of maximum range per 50°F ambient change between -20°F and 210°F
Maximum Operating Pressure: 5000 Psig @ 100°F

Working Pressure:

°F	PSIG	°C	K Pascal
100	1500	35	10,500
200	750	90	5,500
300	250	150	1,700
350	100	175	700
400	25	200	170

Vibration: 10G @ 50 Hz (No glass seal to break)

Housing: Enameled aluminum; 1 conduit conn.

Power: 10 VA @ specified voltage

SUPPLY POWER

M/N	VOLTAGE	M/N	VOLTAGE
A	120 VAC	E	24 VDC
B	240 VAC	F	12 VDC

RELAY STYLE

M/N	DESCRIPTION
D	SPDT; 10 amps @ 240 VAC or 30 VDC
V	Same; except hermetically sealed case

HOUSING RATING

M/N	NEMA	RATING & DESCRIPTION
N4	4 & 13	Hoseproof, Dustproof, Weatherproof
7B	4 & 7B	Class I, Division 1, Group B; Gas Exproof
7C	4 & 7C	Class I, Division 1, Group C & D; Gas Exproof
9E	4 & 9	Class II, Div. 1, Group E, F, & G; Dust Exproof

(1) All standard housings are F.M. plus C.S.A. approved and labeled

"F.M." is Factory Mutual

"C.S.A." is Canadian Standards Association

(2) All housings are available epoxy coated

(3) Second 3/4" NPTF conduit conn. is optional

PROBE STYLE

M/N	MAX °F	DESCRIPTION
1	230	Solid rod
2	400	Rod with temp. extension
3	230	Flexible cable
4	400	Cable with temp. extension
5	230	Knife blade for solids

Cable Strength: More than 1000 pounds; mechanically clamped; specify "brazed" if jerk loaded in service.

INSERTION LENGTH

Solid Rod:

(a) Furnished 14" long; can be cut off in the field; for liquids or solids

(b) Rod extension to 48" long; can be cut off in the field; for liquids only; threaded on

Flexible Cable:

(a) Furnished 60" long; can be cut off in the field; for liquids or solids

(b) Furnished to 150" long; can be cut off in the field; for liquids or solids

(c) Furnished 300" long; can be cut off in the field; for liquids only

Knife Blade:

(a) Furnished 14" long; for side mounting; extra strength for use on solids; 304 SS with composite seal and support.

SIZE & TYPE OF PROCESS CONN.

The standard material is 304 SS; 316 SS is optional. A-105 steel is optional for ANSI flanges only. Other corrosion resistant materials are also available.

Threaded:

3/4" NPT Male process connection

Sanitary:

1 1/2" to 4" Tubing sizes; Ladish or APC; pipe sizes, Acme nut, and other types available.

ANSI Or DIN Flange:

1" (25 mm) or larger; Size/Rating/Face

Open Tank Mounting Bracket: "WBKT"; "HBKT"

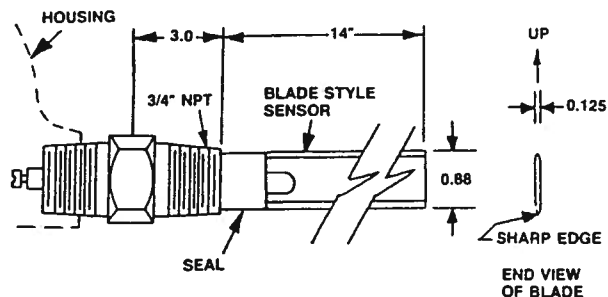
OPTIONAL FEATURES

(1) Time Delay: Adjustable from 1 to 60 seconds, instant reset.

TYPICAL SERVICES

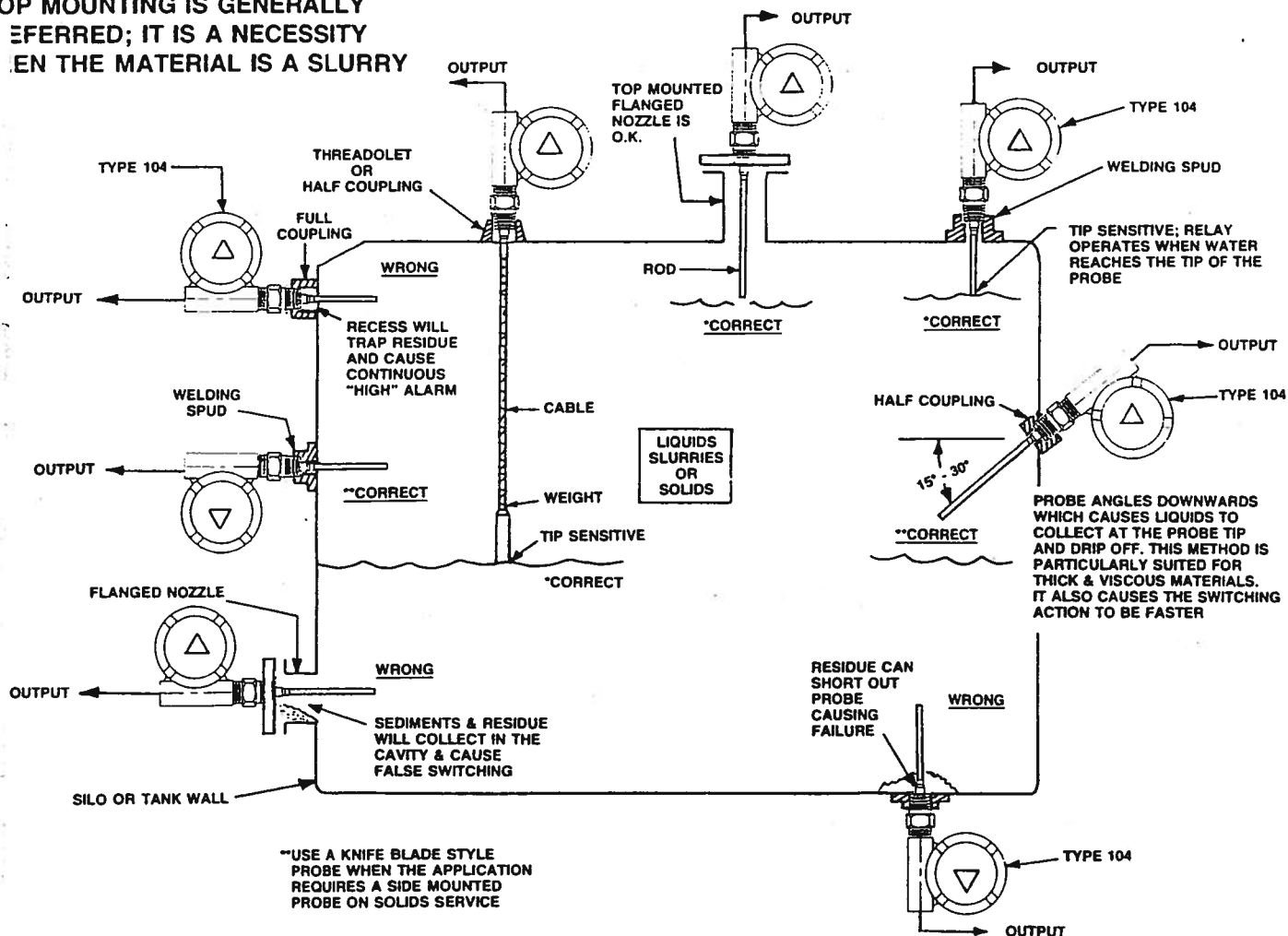
- High level alarm in liquid storage tanks
- Boiling vat "Foam-Over" alarm
- Cement hopper high and low level alarms
- Heating oil tank overflow alarm
- Blending system low tank level shutdown
- Plastic extruding machine hopper level control
- Beer and beverage vat level alarms
- Raw and sliced potato bin levels
- Pumping gallery flood alarm
- Tanker mounted overflow alarm
- Freon and ammonia levels in refrigeration
- Standby fuel oil low level alarm
- Citrus juice packaging machinery and tanks
- Aquaculture water and nutrient control systems
- Subsea oil production modules
- Sanitary milk, food, and pharmaceutical control

TYPE 5 KNIFE BLADE PROBE USED FOR HORIZONTAL MOUNTING IN SOLIDS APPLICATIONS



BEST MOUNTING LOCATIONS FOR MOST SERVICES

TOP MOUNTING IS GENERALLY
PREFERRED; IT IS A NECESSITY
WHEN THE MATERIAL IS A SLURRY



DELTA CONTROLS CORPORATION

1611 TEXAS AVE.
SHREVEPORT, LA. 71103 USA
TELEPHONE: 318-424-8471
TELEX: 784554
FAX: 318-425-2421

LOCAL FIELD OFFICE

FLOW METERS, FE/FT-104, 204, 304

<div style="display: flex; align-items: center;"> <div> <p>Woodward-Clyde Consultants</p> <p>FLOW METERS</p> <p>FT104 FT900</p> <p>FT204</p> <p>FT304</p> </div> </div>		TURBINE FLOWMETERS				SHEET <u>1</u> OF <u>1</u>	
		NO	BY	DATE	REVISION	SPEC. NO.	REV.
						CONTRACT	DATE
						REQ. - P.O.	
						BY	CHK'D APPR.
METER	1	Tag Number	FT 104	FT 204	FT 304	FT 900	
	2	Service	Waste Water	Waste Water	Waste Water	Waste Water	
	3	Meter Location	514a interior	814a	814a	814a	
	4	Line Size	2" inch	2" inch	2" inch	2" inch	
	5	End Connections	Flange	Flange	Flange	Flange	
	6	Body Rating	150 PSI	150 PSI	150 PSI	150 PSI	
	7	Nominal Flow Range	8-200 gpm	8-200 gpm	8-200 gpm	8-200 gpm	
	8	Accuracy	± 1.5%	± 1.5%	± 1.5%	± 1.5%	
	9	Linearity	1.0	NA	NA	NA	
	10	K Factor, Cycles per Vol. Unit					
	11	Excitation					
	12	Materials: Body	Cast Iron	Cast Iron	Cast Iron	Cast Iron	
	13	Support	Cast Iron	Cast Iron	Cast Iron	Cast Iron	
	14	Shaft	Cast Iron	Cast Iron	Cast Iron	Cast Iron	
	15	Flanges	Cast Iron	Cast Iron	Cast Iron	Cast Iron	
	16	Rotor	Ryton	Ryton	Ryton	Ryton	
	17	Bearings: Type	Roller	Roller	Roller	Roller	
	18	Bearing Material	Ceramic	Ceramic	Ceramic	Ceramic	
	19	Max. Speed	115	NA	NA	NA	
	20	Min. Output Voltage					
	21	Pickoff Type					
	22	Enclosure Class	NEMA 4	NEMA 4	NEMA 4	NEMA 4	
	FLUID DATA	24	Fluid	Waste Water	Waste Water	Waste Water	Waste Water
25		Flow Rate: Min. Max.	10 60	10 50	60 75	60 75	
26		Normal Flow	45 gpm	35 gpm	65 gpm	65 gpm	
27		Operating Pressure	50 PSI	50 PSI	50 PSI	50 PSI	
28		Back Pressure	NA	NA	NA	NA	
29		Operating Temp. Max. Min.	40°F 60°F	40°F 60°F	40°F 60°F	40°F 60°F	
30		Operating Specific Gravity	1.01	1.01	1.01	1.01	
31		Viscosity Range	1.0	1.0	1.0	1.0	
32		Percent Solids & Type	IRON 10 PPM	IRON 10 PPM	IRON 10 PPM	IRON 10 PPM	
33							
SECONDARY INSTR.	34	Secondary Instr. Tag No.	NA	NA	NA	NA	
	35	Preamplifier	NA	NA	NA	NA	
	36	Function	Transmitter	Transmitter	Transmitter	Transmitter	
	37	Mounting	Integral w/FT	Integral w/FT	Integral w/FT	Integral w/FT	
	38	Power Supply	12VDC	12VDC	12VDC	12VDC	
	39	Scale Range	NA	NA	NA	NA	
	40	Output Range	4-20mA	4-20mA	4-20mA	4-20mA	
OPTIONS	41	Totalizer Type	LOCAL	LOCAL	LOCAL	LOCAL	
	42	Compensation	NA	NA	NA	NA	
	43	Preset Counter					
	44	Enclosure Class					
	45	Strainer Size & Mesh					
	46						
	47						
	48						
	49	Manufacturer					
	50	Meter Model No.					
	51	Secondary Instr. Model No.					

Notes:

Model INDUSTRIAL TURBO Turbine Meter

FE, FT 104, 204, 304
incoming flow meters

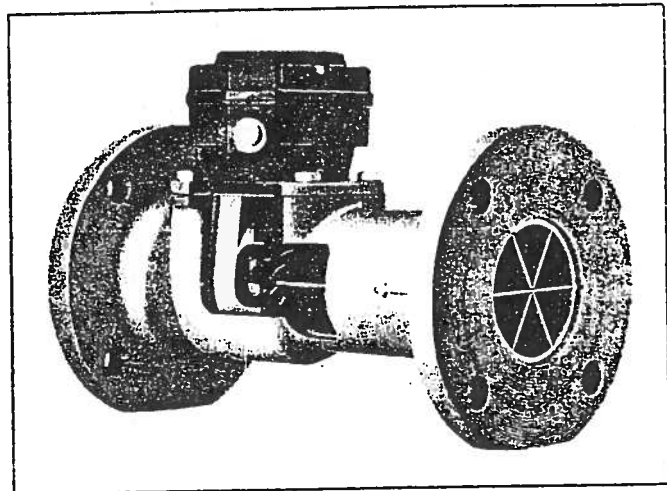
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DESCRIPTION

Badger's Industrial Turbine is a rugged, reliable meter ideally suited for chemical or industrial fluid applications. Its compact size and ease of serviceability without removal of the meter from the line, coupled with a choice of materials, make this a cost effective selection. Designed with performance in mind, the meter provides a high level of accuracy over a wide flow range with a minimum of pressure loss.

The Badger Meter Turbine is available in line sizes of 2", 3", 4" and 6" with a choice of flange ratings and three different body materials which include stainless steel as well as cast iron. Its unique straight through flow profile and ceramic bearing design optimize performance.

To complement the turbine, Badger offers a complete line of accessories that includes mechanical, pneumatic, electromechanical and state-of-the-art electronic transmitters, totalizers, indicators and process controllers.



MATERIAL SPECIFICATIONS

Housing Materials	Cast Iron Bronze 316 Stainless Steel
Rotor and Nose Cone	Ryton
Bearings	Ceramic
Straightening Vanes	316 Stainless Steel
"O" Ring and Tetraseal	Buna-N (Standard) EPR Viton
Head Gasket	Nitrile Binder-used with Buna-N seals
	Chloroprene Binder-used with EPR seals
	EPDM Binder-used with Viton seals

OPERATION

The Badger Meter Industrial Turbine is a volumetric liquid flow meter which works on the time proven principle of a rotor turning at an angular velocity proportional to the fluid velocity through the turbine. The meter has straightening vanes and a nose cone in the inlet side which minimize upstream turbulence and directs the fluid flow to the rotor effectively. Electronic pickups generate signals as the rotor magnet turns. This is translated to 4-20 ma and/or open collector-transistor outputs. Mechanical pickups and electromechanical outputs are also available.

FEATURES

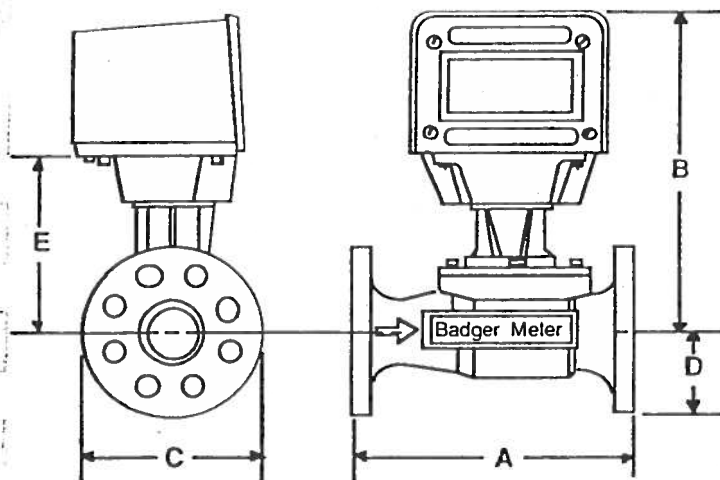
- Long Lasting Ceramic Bearings
- Simple In-Line Serviceability
- Flow Profile Conditioning
- Three (3) Housing Materials Available
- 0.5% Accuracy
- 0.25% Repeatability
- Low Pressure Loss
- ANSI Flanged (150 or 300 psi)



Badger Meter, Inc. Industrial Division

4545 W. Brown Deer Road, P.O. Box 23099, Milwaukee, WI 53223-0099

(414) 355-0400 Fax: (414) 355-7499 Telex: WU 2-6757 — RCA 201313



Dimensions shown are of meter with a PC meter mount. Dimensions for other system configurations may vary slightly. Please consult with the factory.

	2"	3"	4"	6"
A	10.00	12.00	14.00	18.00
B	13.67	13.67	15.34	16.84
C-150#	6.00	7.50	9.00	11.00
C-300#	6.50	8.25	10.00	12.50
D-150#	2.75	3.50	4.25	5.25
D-300#	3.00	3.87	4.75	6.00
E	6.86	6.86	8.53	10.03
Est. Wgt Per Unit in (Lbs)	30-40	40-50	60-75	100-125

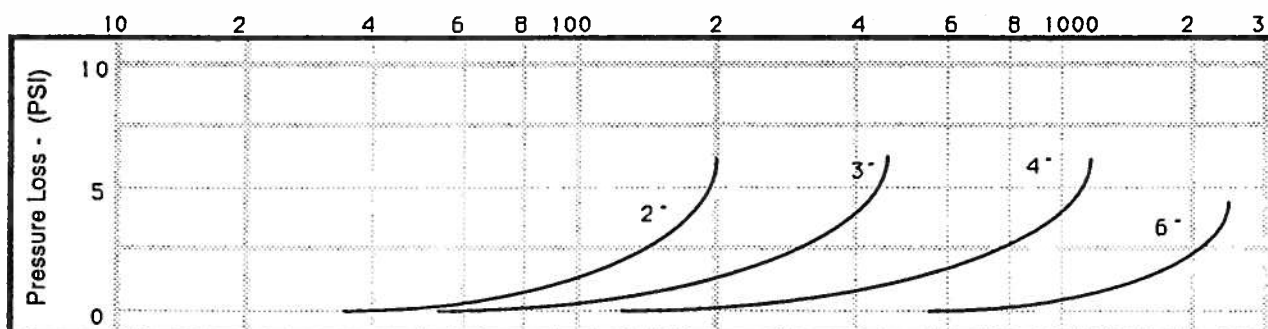
All dimensions in inches

METER SPECIFICATIONS


	2"	3"	4"	6"
Accuracy $\pm 0.5\%$ @ indicated Flow Range - gpm	20-160	60-350	100-1000	250-2000
Accuracy $\pm 1.5\%$ @ indicated extended Flow Range - gpm	8-200	10-450	25-1250	40-2500
Repeatability (*)	0.25%	0.25%	0.25%	0.25%
Approx. Weight (Lbs.) with 150 psi Flanges (Hsg Matl Determines Wgt)	30-40	40-50	60-75	100-125
Temperature Range (°F)	-30 to 250	-30 to 250	-30 to 250	-30 to 250
Maximum Operating Pressure (PSI)	150 Std 300 Opt	150 Std 300 Opt	150 Std 300 Opt	150 Std 300 Opt

* Reading over full range tested with potable water @ 60°F

Industrial Turbine Meter Pressure Loss Chart – Rate of Flow in Gallons Per Minute



BUILDING SUMP LEVEL, LSH-1000

 Woodward-Clyde Consultants <i>Sump Level Switch</i> <i>LSH-1000</i>			LEVEL INSTRUMENTS (DISPLACER or FLOAT)				SHEET <u>1</u> OF <u>1</u>	
							SPEC. NO.	REV.
			NO	BY	DATE	REVISION	CONTRACT	DATE
							REQ.	P.O.
				BY	CHK'D	APPR.		
BODY/CAGE	1	Tag Number	<i>LSH-1000</i>					
	2	Service						
	3	Line No./Vessel No.	<i>Bldg. Sump</i>					
	4	Body or Cage Mtl	<i>Cast Iron</i>					
	5	Rating	<i>NEMA 6</i>					
	6	Conn Size & Location Upper	<i>NA</i>					
	7	Type	<i>NA</i>					
	8	Conn Size & Location Lower	<i>NA</i>					
	9	Type	<i>NA</i>					
	10	Case Mounting	<i>Side mounting</i>					
	11	Type	<i>NA</i>					
	12	Rotatable Head	<i>NA</i>					
DISPLACER OR FLOAT	13	Dimensions	<i>2.50" dia.</i>					
	14	Insertion Depth	<i>NA</i>					
	15	Displacer Extension	<i>NA</i>					
	16	Disp. or Float Material	<i>SS</i>					
	17	Displacer Spring/Tube Mtl	<i>SS</i>					
	18							
	19							
XMTR/CONT.	20	Function	<i>SWITCH</i>					
	21	Output	<i>Controlled</i>					
	22	Control Modes	<i>NC, NO</i>					
	23	Differential	<i>.75"</i>					
	24	Output Action: Level Rise	<i>SWITCH Closure</i>					
	25	Mounting	<i>VERT</i>					
	26	Enclosure Class	<i>NEMA 6</i>					
	27	Elec. Power or Air Supply	<i>NA</i>					
	28							
SERVICE	29	Upper Liquid	<i>Water</i>					
	30	Lower Liquid						
	31	sp. gr.: Upper	Lower					
	32	Press. Max.	Normal	<i>AMBIENT</i>				
	33	Temp. Max.	Normal	<i>AMBIENT</i>				
	34							
OPTIONS	35							
	36	Airset Supply Gage	<i>NA</i>					
	37	Gage Glass Connections						
	38	Gage Glass Model No.						
	39	Contacts No. Form						
	40	Contact Rating						
	41	Action of Contacts						
	42							
	43							
	44							
	45							
	46	Manufacturer						
	47	Model Number						
	48							

Notes:

ISA FORM S20 26



*LSH-1000
Building Sump*

**DESCRIPTIVE DATA
MODEL FLS
FLOOD LEVEL SWITCH**

**TYPICAL MODEL FLS
APPLICATIONS**

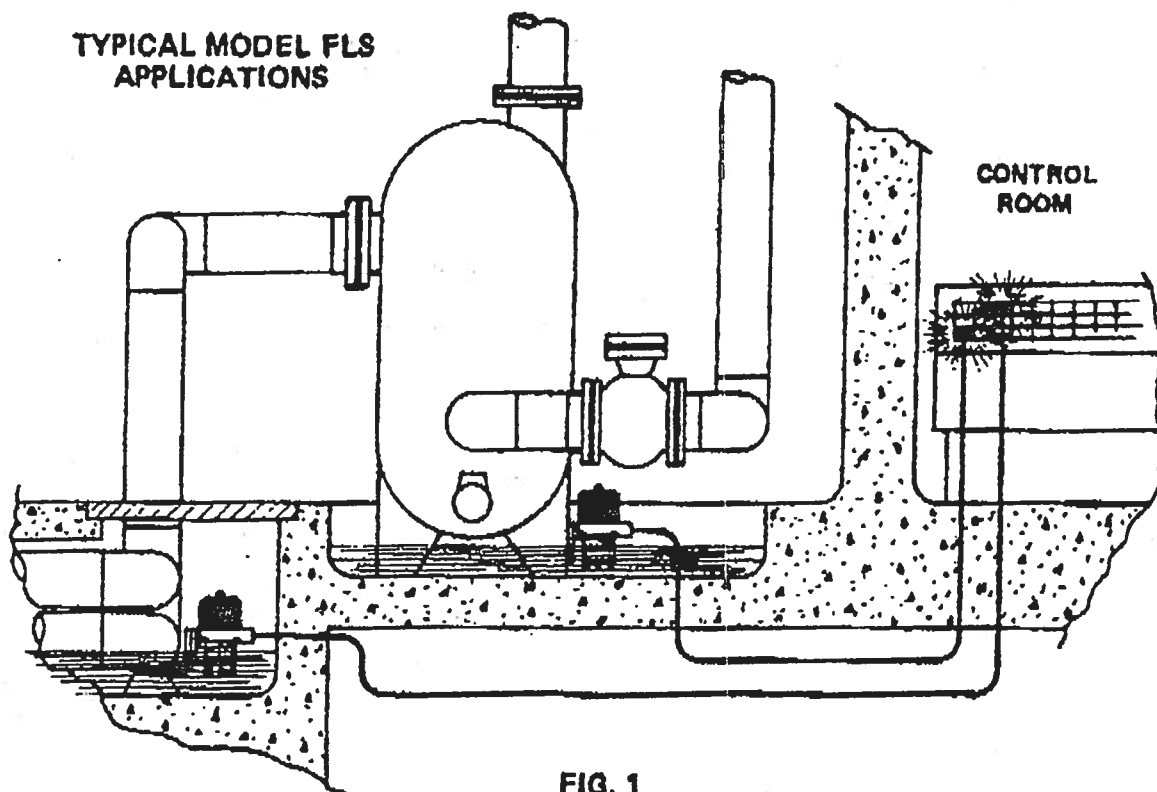


FIG. 1

DESCRIPTION

The Model FLS instrument is a float operated liquid level control designed for bracket mounting in floor level sumps or troughs. The proven Magnetrol® magnetic coupling is employed to transmit float movement to the electrical switch.

The Model FLS utilizes a single snap action dry contact switch mechanism with factory set $\frac{1}{2}$ " level differential for off-on control—alarm and/or safety shut-down service.

APPLICATIONS

The Model FLS control is ideally used to detect leaks or spills from critical valves, vessels and pipe lines in power plant installations, as typically illustrated in Fig. 1 above.

CONSTRUCTION

Simple and rugged in design, the Model FLS is constructed of quality materials throughout to assure reliable operation and a long trouble-free service life.

FLOAT ENVELOPE

A perforated stainless steel float envelope is welded to a forged steel bracket assembly to totally enclose the float and provide a side mounting surface. A stainless steel bottom strap is tack welded to the float envelope to act as a low level float stop.

FLOAT AND TRIM

A 300 series stainless steel float is used in the Model FLS. A 400 series magnetic attraction sleeve is employed with balance of internal trim of 300 series stainless steel.

CONSTRUCTION—continued

SWITCH MECHANISM

The Magnetrol series B switch mechanism with SPDT contacts is standard in the Model FL6, carrying the following electrical ratings:

15A resistive & 3.8A inductive @ 120VAC
0.50A resistive & 0.05A inductive @ 120VDC
180°F. maximum ambient temperature

SWITCH HOUSING

A NEMA 6, 7 and 9 cast iron submersible electrical enclosure is standard, designed to allow 180° positioning of the conduit outlet for wiring convenience.

AVAILABLE OPTION

Qualified to IEEE 323-1974, and IEEE 344-1975.

DIMENSIONAL DATA

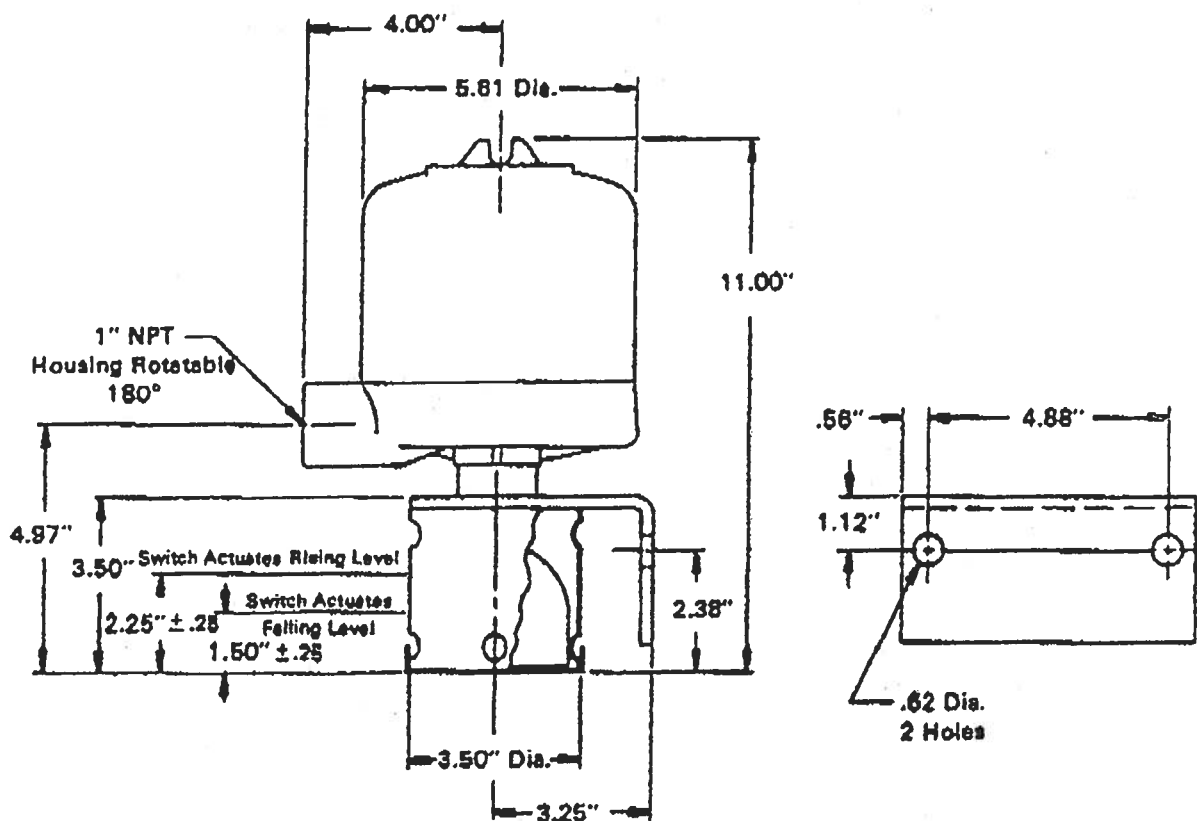
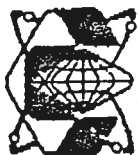


FIG. 2



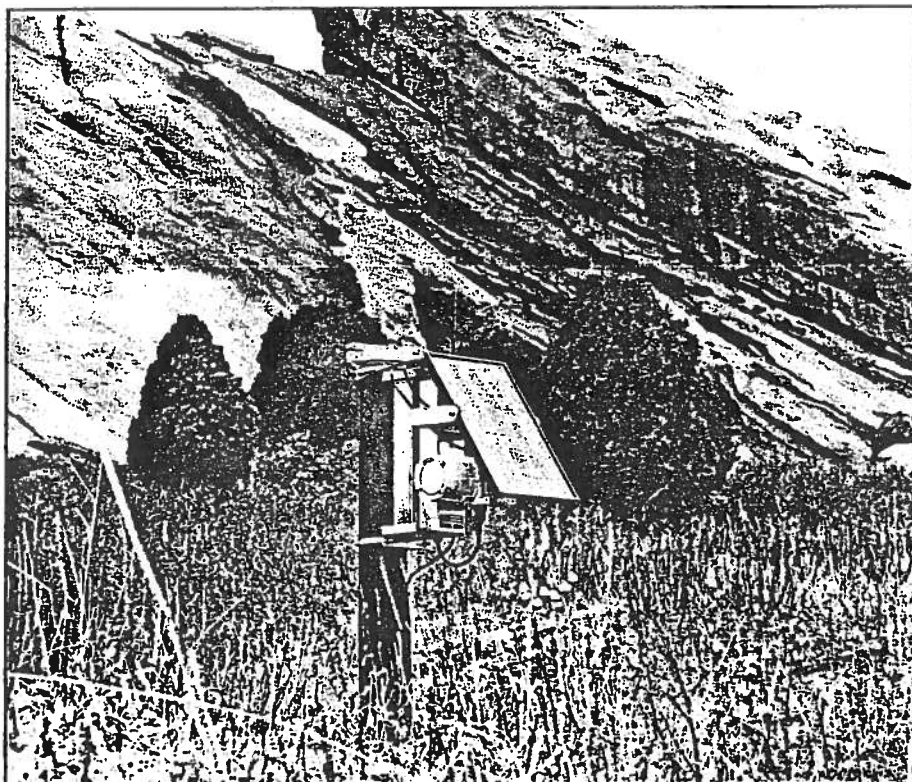
MAGNETROL
INTERNATIONAL, INCORPORATED

5300 Belmont Road • Downers Grove, Illinois 60515 • (312) 969-4000 • Telex 25-3085
6291 Dorman Road • Mississauga, Ontario L4V 1H2 • (416) 678-2720 • Telex 06-968502
Industriemark Rink F • 0140 Zela, Belgium • Phone: 052-445901 • Telex 846-25844

MONITORING WELLS - REMOTE MONITORING SYSTEM

PRODUCT DATA

2370 SERIES REMOTE MEASUREMENT & CONTROL UNITS (MCUs)



2370 MCU and AP-7015 Solar Power Unit attached to monitoring well casing.

USES

ENVIRONMENTAL

- ☐ Water Quality
- ☐ Air Quality
- ☐ Hydrology
- ☐ Airport & Community Noise Monitoring

GEOTECHNICAL/STRUCTURAL

- ☐ Dam Performance Monitoring
- ☐ Dam Early Warning Systems
- ☐ Slope Stability Monitoring
- ☐ Pipeline Stress/Strain Monitoring
- ☐ Tunnel/Mining Instrumentation

REMOTE FACILITIES MONITORING & CONTROL

- ☐ Municipal Water & Wastewater
- ☐ Natural Gas Distribution
- ☐ Irrigation Control
- ☐ Gas Well Production Optimization
- ☐ Enhanced Oil Recovery
- ☐ Mining Operations

TEST/RESEARCH

- ☐ Hydro/Geologic Permeability (Well Testing)
- ☐ Hydrology
- ☐ Sediment Transport Studies
- ☐ Lake/Stream Contaminant Monitoring
- ☐ Agricultural Research (ET, Agronomy)
- ☐ Meteorology

FEATURES

APPLICATION

- Configurable for a variety of input and output functions
- Designed for automation of widely distributed instruments, tests and processes
- Economical radio-linked configurations
- Multiple communication strategies for local- and wide-area networks: radio, wireline, fiber-optic, cellular telephone
- Operates over wide temperature extremes to withstand even the harshest environments
- Solar, replaceable alkaline battery, and AC input/UPS power options
- Lowest cost/highest performance standard product solution available for retrofit field automation projects

INSTALLATION

- Economical automation of randomly distributed instrument locations
- Eliminates extensive buried signal cable
- Easily transportable for system re-installation at alternate sites, to accommodate changing field situations
- NEMA 4X packaging to eliminate reliability risks associated with outdoor installations
- Designed for direct attachment to well casings or other exterior structures
- Explosion-proof packaging options for installation in hazardous environments

OPERATION

- No software development required: complete standard product solution for real-time monitor and control
- Simple user programming of Remote Units using menus and fill-in-the-blanks screens on a Personal Computer
- Fully compatible with GEONET Communications Protocol(GCP) and existing System 2300 Measurement & Control Networks
- Support of 2350 and 2370 Series Remote Units on the same network
- Digital Message Routing (store-and-forward) to expand geographical deployment and overcome terrain obstructions
- Direct Unit-to-Unit (peer-to-peer) communications for distributed automation without "Host" arbitration
- Arbitrary Network Topologies are totally user programmable
- Internal diagnostics for MCU and network status monitoring

DESCRIPTION

The 2370 Measurement & Control Unit (MCU) is designed as an integrated radio networked package, with ultra-low power consumption for operation with alternate energy sources. It is designed for random-area deployment at the source of instrumentation devices in harsh outdoor environments.

The 2370 offers new standards of economy and reliability, allowing installation of a full-capability MCU for just a single instrument. For projects with outdoor instrument arrays, such as embankment dam piezometers, water quality monitoring wells, and enhanced oil recovery injection and production wells, the 2370 eliminates all need for trenching, buried conduit, and signal cable runs. Retrofit projects are far easier to implement, and new projects are not constrained from a design standpoint.

In most remote environments it is difficult, and often prohibitively expensive, to extend power or communication facilities to many instrument locations. Likewise, it is undesirable in outdoor situations to install long signal cable extensions to clustered or "hub" data collection or control facilities, that may otherwise be networked to a Central Station.

The cost of quality cabling facilities in outdoor environments usually exceeds the cost of the automation systems employed in these installations. Further, the vast extent of permanently installed facilities complicates the maintenance of the automation system as a whole. Considering the impact of system complexity, installation time and risk, and long term maintenance, the 2370 MCU is the preferred solution for randomly distributed or arrayed field automation projects. Since the System is fully transportable using 2370 MCUs, there is no need for concern that your instrument automation objectives may change over time.

The 2370 is compact and highly integrated, far beyond any industry comparison. Options in the 2370 Series include the power system, radio, antenna, data communication functions, instrumentation interfaces, transient protection, extensive applications firmware, and rugged NEMA 4X packaging. No field fitting of watertight equipment enclosures is necessary, which makes the 2370 quick and inexpensive to install.

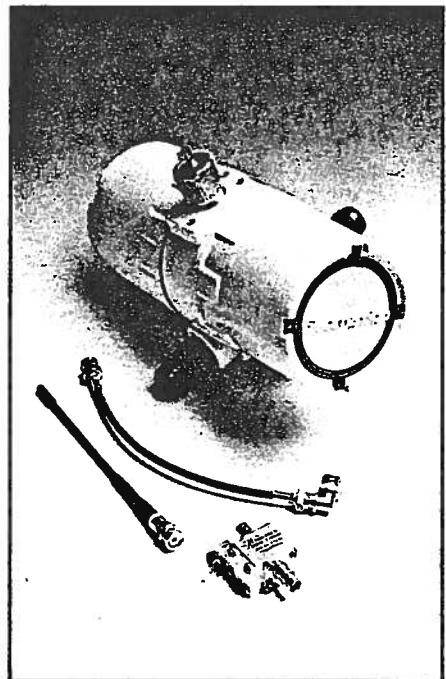
With field installed automation systems, the installation materials, techniques and procedures are critical to system reliability. But we've solved all that for you; the 2370 comes complete out of the box with all hardware and standard product software, ready for installation in the rain, snow and blowing sand. It is designed to eliminate performance and reliability risk associated with project-specific custom software and hardware, and the ad hoc installation procedures that invariably occur in the field with pieced-together systems. And no matter what the experience level of the installer, the 2370 minimizes the time and cost of installation.

While the 2370 offers new breakthroughs in cost, performance is not compromised. The 2370 implements all the power, performance, flexibility in communications, and precision in instrumentation functions as our well proven 2350 series MCUs. 2370s are fully compatible with GEONET Communications Protocol (GCP), so you can intermix 2350s and 2370s on the same network.

For applications requiring larger concentrations of modular I/O, please request product data on Geomation 2350 Series MCUs.

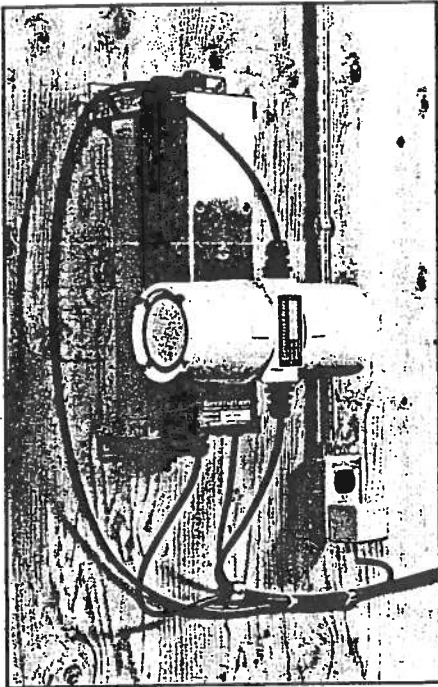
MODEL CONFIGURATIONS

The Model 2370 is a standard, highly integrated radio linked unit with a flexible basic set of instrumentation interface capabilities. However, there are 3 additional models in the 2370 Series, which are all subsets of 2370 capabilities, with regard to either communications or instrumentation functions. These additional models are offered to accommodate variations in system configuration and application requirements, where specific 2370 functions are not required:



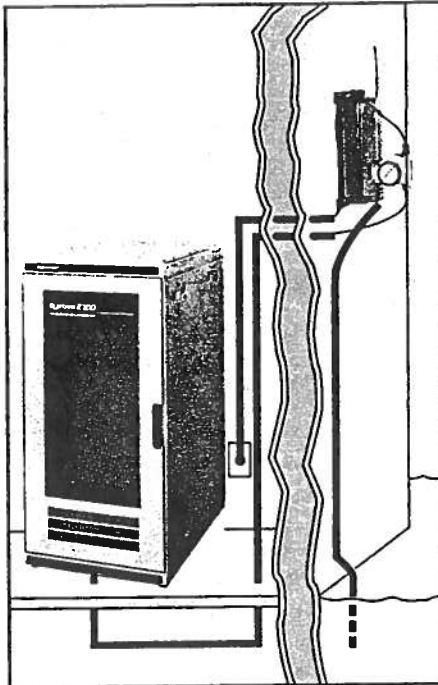
2370 MCU with included RF components.

□ 2370 MCU - Radio unit with the basic instrumentation functions installed. This is the primary product in the series, since most applications for the product series require radio linkage as well as analog instrumentation functions.



2371 MCU and AP-7013 Uninterruptible Power Unit, wall mounted, wireline linked installation.

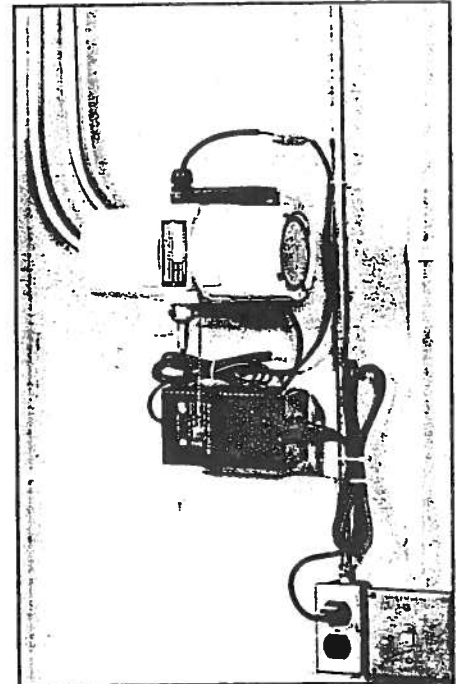
□ 2371 MCU - This model includes the basic instrumentation functions but does not include the radio and the associated RF components. It does include the wireline (multidrop) modem interface. Therefore, the 2371 is used as a measurement/control node in a network where a hardwire communication link is practical. Distributed instrumentation interior to a structure or facility would be an appropriate application of the 2371. 2371s can be multi-dropped on a single twisted wire pair.



2372 NRU and AP-7013 Uninterruptible Power Unit, used as radio network gateway to the NM-2310 Network Monitor Station (NMS). NMS shown with AI-1080 Rack Cabinet installation.

□ 2372 NRU - This Network Repeater Unit is a communication node only; it does not contain the basic instrumentation functions. The 2372 is a radio unit, with two primary purposes: 1) a network gateway, to transition from the serial I/O port on the Network Monitor Station (NMS) to the Geomatics RAN (Remote Area Network), and 2) a store-and-forward radio digital repeater, for the purpose of extending radio range and/or overcoming terrain obstructions for reliable radio communication.

The AP-7015 or AP-7016 Solar Power Systems would be used instead of the AP-7013 for Repeater Sites where AC power mains are unavailable.

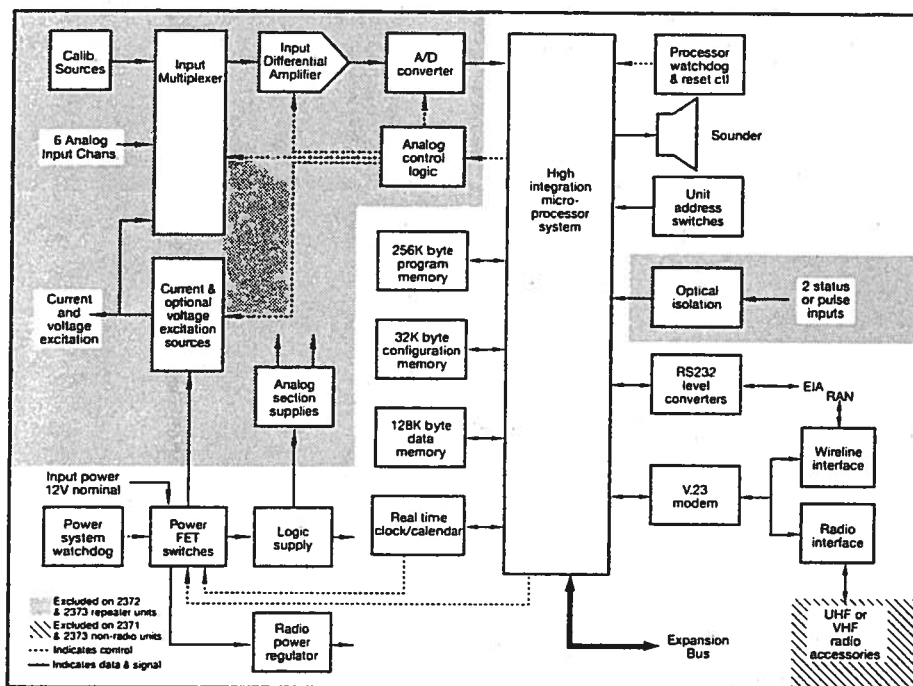


2373 NRU with AP-7012 Power Supply and AI-7080 Wall Mount Bracket.

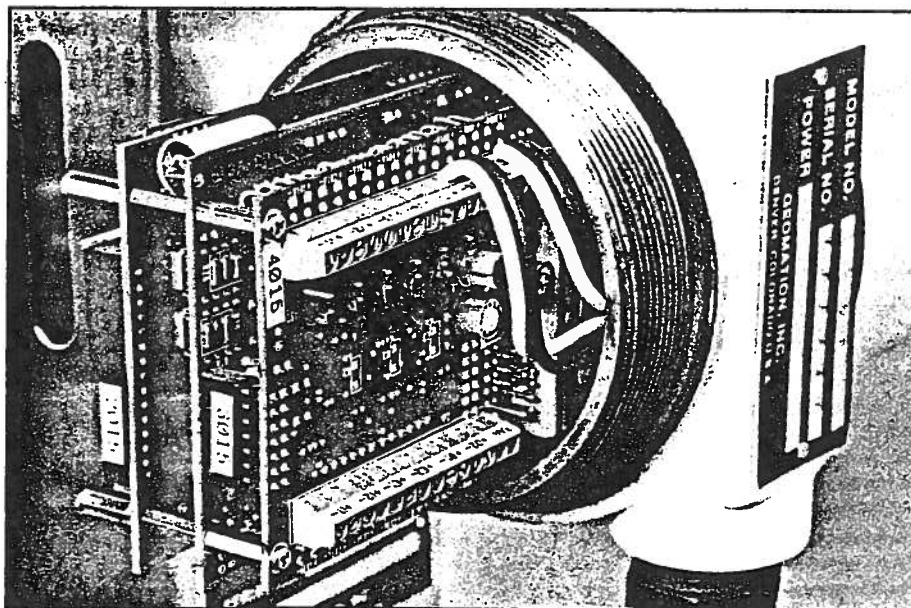
□ 2373 NRU - Like the 2372, this is a Network Repeater Unit and a communication node only, with no instrumentation functions. The 2373 does not have a radio installed, and its purpose is a network gateway from the NMS to the RAN using wireline linkage, or perhaps the optional Fiber Optic Link.

Any 237X Remote Unit can be fitted with one of the option boards. Option expansion boards for both instrumentation and communication functions are available.

HARDWARE CONFIGURATIONS



2370 MCU block diagram.



2370 Termination Board showing user connection terminals.

BASIC INSTRUMENTATION FUNCTIONS

In order to permit maximum measurement and transducer excitation flexibility in a compact package, field wiring terminals are provided for the following:

- Voltage Inputs (6): labeled $V_1 \dots V_6$
- Voltage Excitation Outputs (2): labeled E_1 & E_2
- Current Excitation Outputs (2): labeled I_1 & I_2
- Pulse/Digital Inputs (2): labeled D_1 & D_2

In addition, jumpers are provided for all 6 user analog inputs ($V_1 \dots V_6$) which permits selecting an on-board 100Ω current shunt for any or all 6 input channels. Current measurements can then be made on one of 2 voltage ranges on any of the 6 channels.

An internal $100\mu A$ current source is directed by user programming to the I_1 & I_2 terminals for making unknown resistance measurements. The same current source is automatically switched during resistance measurements to an internal $10 k\Omega$ reference resistor, making resistance measurements self-calibrating (pseudo-ratiometric). This current source is also switched to an on-board thermistor for making the MCU internal temperature diagnostic measurement.

Two power supply plug-in positions are connected to the E_1 & E_2 field wiring terminals. The excitation voltage available at each of these terminals depends upon the optional power supply selected. In addition, on-board jumpers for each power supply permit selection of single-ended or differential excitation mode, so that strain gauge bridges can be directly excited and measured. See the SPECIFICATIONS section following for a list of the available power supply options.

SPECIFICATIONS

PROCESSOR/CONTROLLER

CPU: NEC V25 Plus
Program Memory: EPROM; 256kB
Configuration Database Memory: EEPROM;
32 kB
Data & Run-time Memory: Non-volatile static
CMOS; 128 kB
Calendar Clock/Timekeeper: Non-volatile
Reset Control: Watchdog, power on, operator
command, miser-mode wakeup
Physical Address Switches: 4-character HEX (256
nets; 256 nodes)
Sounder & LEDs For Local Diagnostics

COMMUNICATIONS

UNIT OPTIONS

2370 & 2372: Radio units including integrated
NEMA 4X packaging, surge suppressor, RF
cable and connectors, and whip antenna
2371 & 2373: Units with integrated NEMA 4X
packaging for non-radio RAN linkage only:
RS-232, wireline, optional telephone modem,
or optional fiber optic modem

SYSTEM 2300 COMMUNICATIONS COMPATIBILITY

Protocol: GEONET Communications Protocol
(GCP)
Message Format: Based on Synchronous Data
Link Controller (SDLC)
Design Reference: ISO Model For Open Systems
Interconnection
Error Detection Algorithm: CCITT CRC-16
GCP Supported Features:
User specified logical names for network nodes
User programmable message routing (store-
and-forward)
Peer-to-peer communications
Multiple operator workstations on the same net-
work
Multiple logging destinations
Automatic node-polling for link-failure
detection/annunciation

STANDARD RAN (REMOTE AREA NETWORK) PORTS

Serial data channels included in the basic models
for inter-network (RAN) data communication:
1 modem channel (strapped for radio or wire-
line)
1 EIA RS-232 channel
Modem Channel:
Signaling: CCITT V.23, half-duplex
Data Rate: 1200 bps

EIA RS-232 Channel:

Uses: Network Gateway function (connection
of NMS or PNM), or external instrument
connect
Data Rate: 300, 1200, 2400, 4800, 9600 bps;
software configured

OPTIONAL DATA COMMUNICATIONS

Implemented via expansion board. One expan-
sion board permitted

2370-400 (TNM) Telephone Network Modem:
For auto-dial and auto-answer inter-network
(RAN) communication; Bell 212A Std., Hayes
2400 compatible
2370-401 (SIO) 2nd EIA and RAN Wireline
Option; provides additional EIA RS-232, and
multi-drop wireline ports
2370-402 (FOL) Fiber Optic Link: For multi-drop
fiber optic RAN data communication
2370-403 (SDI) 2nd EIA and SDI-12 Interface
Option; provides additional EIA RS-232 port,
and serial interface compatible with U.S.
Geological Survey standard for low power
intelligent sensors

RADIO TRANSCEIVER SPECIFICATIONS (2370 & 2372)

Supported Frequency Bands*:

150.8-174.0 MHz
403.0-424.0 MHz
450.0-470.0 MHz

Receiver:

Sensitivity: 12 dB SINAD < 0.45 μ V
Frequency Stability: \pm 10 PPM
Selectivity: 60 dB
Intermodulation: 60 dB
Spurious Rejection: 55 dB
Image Rejection: 50 dB
Carrier Detect Attack Time: < 20 ms

Transmitter:

RF Power Out: 2-4 Watts (factory adjustable
for license)
Frequency Stability: \pm 5 PPM
FM Hum & Noise: 40 dB
*U.S. FCC Type Acceptance; Canadian DOC
Type Acceptance Pending.

INSTRUMENTATION

SUPPORTED INSTRUMENTATION APPLICATIONS (2370 & 2371)

Standard Analog:

Voltage inputs
Current inputs
2-terminal resistance
4-terminal resistance
Potentiometers

Standard Pulse/Digital:

Status
Event/time of event
Period
Pulse accumulator
Pulse Frequency

Additional Analog With Appropriate Optional
Plug-in excitation Power Supply(s):
4-20 mA current transmitters
Direct-connect strain gauge bridges and bridge
transducers

Additional Instrument Interfaces With Optional
expansion board:
Vibrating wire instrument inputs with 2370-060
Vibrating Wire Converter
Multi-channel status inputs and digital outputs
with 2370-061 Status and Control Interface

SUPPORTED PERIPHERAL RS-232 INSTRUMENTS

Water Quality:

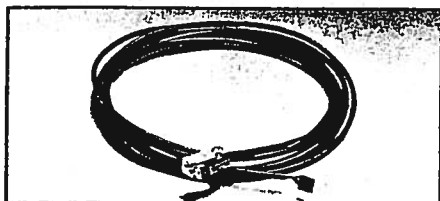
Hydrolab "H20" multiparameter water quality
probe (temperature, dissolved oxygen, %
saturation, specific conductance, salinity,
TDS, pH, REDOX, depth)

I/O CONFIGURATIONS & PERFORMANCE

Analog inputs:

6 user inputs, bi-polar, differential
Current shunt options by jumper selection:
100.00 Ω
Ranges: autorange (\pm 12 V, \pm 20 mV)
Common-mode range: \pm 12 V
Input Impedance: > 100 M Ω
CMRR (DC, 50/60 Hz):
105dB (\pm 120mV Range)
86 dB (\pm 12 V Range)

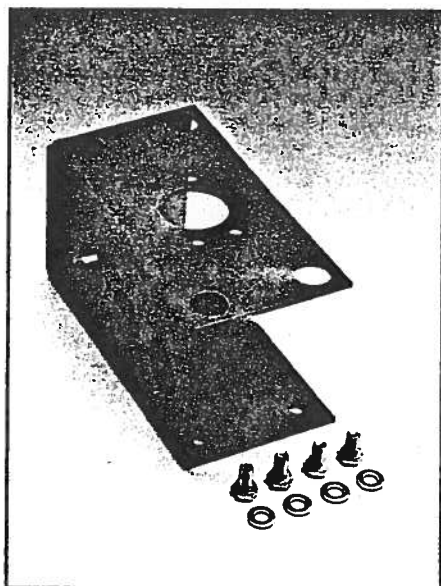
PNM CONNECTION CABLE (CD-7003)



CD-7003 PNM Connection Cable.

This is a 20' (6m) cable to make temporary field connection to the standard internal EIA RS-232 port with the PNM. This cable is intended for temporary test/diagnostics of the MCU/NRU with the PNM. Use of this cable requires opening the Remote Unit for access to the on-board connector.

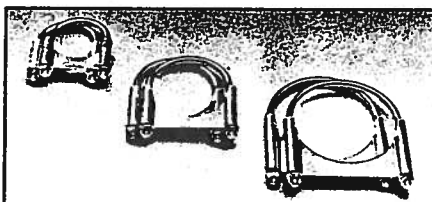
MCU WALL MOUNTING BRACKET



AI-7080 MCU Wall Mounting Bracket.

This bracket is required if the MCU is to be powered by the AP-7012 AC/DC Power Supply, or a user furnished power supply. All other Power Units (AP-7013, AP-7015, AP-7016, & AP-7017) provide integral mounting facilities for 2370 Series Remote Units.

POWER UNIT PIPE CLAMP SETS (AI-7082, AI-7083, & AI-7084)

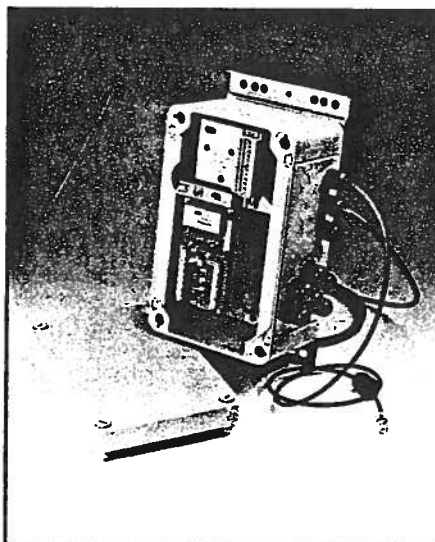


AI-7082, AI-7083, & AI-7084 Power Unit Pipe Clamp Sets.

Clamp sets are available in 3 different sizes to allow mounting any of the remote Power Units to a wide size range of pipes, masts, or well casings. Any of the 3 clamp sets adapt to the mounting flanges of the Power Units.

Maximum pipe O.D. is 2-3/8" (6.03cm), 3-3/8" (8.57cm), and 4-5/8" (11.75cm) for the AI-7082, AI-7083, & AI-7084 respectively. These Clamp Sets include tamper-resistant break-away nuts, which can be used at the option of the customer. Conventional fasteners are also included for locations where higher security is not a concern, and it is desirable to easily relocate the entire Remote Unit.

EXPANDED MCU HOUSING (AI-7091)

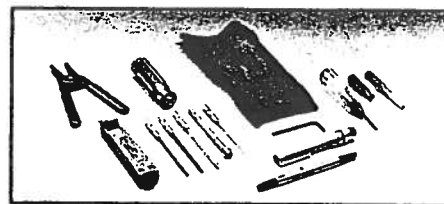


AI-7091 Expanded MCU Housing.

When multiple instruments are connected to a 2370 MCU, the AI-7091 Expanded MCU Housing is required to facilitate transducer wiring and provide bussing for excitation signals. As a general rule, if more than 2 transducers are to be connected to a 2370 Series MCU, then the Expanded MCU Housing is required.

The AI-7091 is a NEMA 4X rated molded fiberglass enclosure, with fluid-tight cable glands for up to 6 instrument cable entries. Terminals are provided for common excitation connections to multiple transducers. The AI-7091 Expanded MCU Housing replaces the standard 2370 series housing.

SPECIALIZED TOOL KIT (AI-7099)



AI-7099 Specialized Tool Kit for 2370 Series Remote Units.

The Specialized Tool Kit includes those tools required for the tamper resistant fasteners used on the 2370 outdoor packaging. It also includes other tools to facilitate installation and maintenance of 2370 Series Remote Units. The kit is not a complete set of all tools required for installation; it is intended to complement general purpose tools.

The kit includes the following: 1- $\frac{1}{2}$ short arm hex key (tamper resistant), 1- $\frac{1}{2}$ hex driver (tamper resistant), 1- $\frac{1}{2}$ nutdriver, 1-tool handle, 1- $\frac{1}{16}$ nutdriver bit, 1- $\frac{1}{32}$ hex bit, 1- $\frac{1}{4}$ hex bit, 1- $\frac{1}{8}$ slotted screwdriver bit, 1-#1 Phillips screwdriver bit, 1- $\frac{1}{2}$ slotted screwdriver, 1-multi-gauge wire stripper, 1-cable jacket stripper, 1-miniature flashlight, 1-permanent marker pen. At least one AI-7099 should be ordered with any system.

MEASUREMENT, PROCESSING & CONTROL FUNCTIONS

The 2370 Series MCUs implement generally the same user accessible software functions as the 2350 Series MCUs. Signal processing and control functions are linked to input measurement functions by the easy-to-use, screen oriented programming methodology supported in GEONET. No familiarity with procedural programming languages is required.

GEONET is a Geomation developed and supported software program for configuration database management, data acquisition, alarm annunciation, and supervisory control. Network topology tables and MCU "Configurations" are created at the NMS or PNM through GEONET, and downloaded to 2370 Series MCUs. GEONET is designed to be used in both an operator interactive mode or an on-line automatic unattended mode. These modes can function concurrently. GEONET operational features are described in detail in other Geomation publications.

Measurement and control functions are linked and further processed by cross-channel arithmetic and boolean operators. All sequencing of measurements, processing, execution of control functions, and data & alarm logging occur under the control of user programming.

TRIGGERING OF EVALUATION SEQUENCES

The evaluation of user-configured measurement and control sequences can be triggered through multiple mechanisms:

TIME-OF-DAY PERIODIC SCHEDULING

PERIODIC SCHEDULING UNDER CONDITION

- upon a prior evaluation exceeding a threshold
- upon an alarm condition or an alarm condition in need of acknowledgement
- upon a digital status input condition

ONE-SHOT EVENT TRIGGERING

- upon another evaluation first exceeding a threshold
- upon an alarm record entering alarm condition, exiting alarm condition, first needing acknowledgement, or becoming acknowledged
- upon state change of a digital status input

EXTERNALLY FORCED TRIGGERING

- upon operator commands
- initiated as a result of evaluations in another MCU

LOGGING CONTROL

Handling of the volume of data acquired under user programmed conditions is provided through versatile logging control features. Each measurement or control record may be independently set to:

DISABLE ALL LOGGING (except under operator command)

LOG EVERY Nth SCHEDULED EVALUATION (or every Nth exceptionally triggered evaluation)

LOG ONLY IF THE VALUE EXCEEDS A THRESHOLD

LOG ONLY IF THE VALUE HAS CHANGED BY A PROGRAMMABLE AMOUNT FROM THE PREVIOUS LOGGED VALUE

Further control of the disposition of logged data is provided through the *logging class* feature. This allows user control of the flow of logged data into historical files, data presentation screens, and printed records at the ultimate logging destination(s).

The following is a summary list of standard PROM resident functions available for user programming in 2370 Series MCUs:

INPUT FUNCTIONS

INPUT FUNCTIONS refer to the initial or raw physical measurements that can be acquired by the MCU. Invoking these functions requires the proper hardware configuration, and some functions may require the installation of hardware options or peripheral instruments. The following are supported functions:

VOLTAGE
VOLTAGE RATIO
RESISTANCE
CURRENT
VIBRATING WIRE PERIOD
INCREMENTAL ENCODER POSITION
DIGITAL INPUT DECODE
PULSE ACCUMULATOR
PULSE RATE
PULSE PERIOD
STATUS
TIME OF EVENT
TIME INTERVAL
MANUAL DATA INPUT

OUTPUT FUNCTIONS

OUTPUT FUNCTIONS allow the configuration of the elementary output device. In the case of the 2370 Series MCU, this device is either a relay or digital signal output. Invoking the OUTPUT FUNCTION allows user specification of the logic state and the behavior parameters for the output channel (i.e., held, momentary, duration). Output functions are then activated based upon user programming of SIGNAL PROCESSING FUNCTIONS and/or CONTROL FUNCTIONS.

RELAY OUTPUT
DIGITAL OUTPUT

SIGNAL PROCESSING FUNCTIONS

SIGNAL PROCESSING FUNCTIONS refer to operations that are performed subsequent to the raw or initially measured data. Some functions of this type have more than one measurement specified as input parameters. User specified constants are also normally allowed for these functions.

Signal Processing Functions can be linked together so that the parent of a processing operation was a prior function of the same category. As an example, an ALARM function can follow a LINEAR TRANSLATION which previously converted the raw transducer VOLTAGE measurement into engineering units. But before we apply the ALARM function, we may also want to apply the LOW PASS FILTER function to the measured data, so that a spurious measurement does not evaluate to an alarm condition.

The ALARM function also has its own relay output control capability.

ALARM
AVERAGE
NUMBER OF SAMPLES (in the Average)
MIN/MAX
TIME OF MIN/TIME OF MAX
STD DEVIATION
LINEAR TRANSLATION
NON-LINEAR TRANSLATION
INTERCHANNEL COMPUTATIONS
POLAR to CARTESIAN TRANSFORMATION
CARTESIAN to POLAR TRANSFORMATION
VECTOR AVERAGE
THERMISTOR LINEARIZATION
OPEN CHANNEL FLOW (weirs/flumes)
VW TRANSDUCER CALCULATION
EGM (AGA-3, AGA-5, AGA-7)
LOW PASS FILTER
RATE OF CHANGE
TIME INTEGRATION

CONTROL FUNCTIONS

CONTROL FUNCTIONS refer to specific types of either elementary or industry standard operations whose input parameters are user specified measurements, evaluations, time, and conditional events. These operations provide a PROM resident set of tested, proven, and documented functional elements enabling users to program more complex control strategies. This allows users and systems contractors to customize the automation system for specific requirements while avoiding the inevitable pitfalls of custom, project specific applications software.

Unique addresses specified by the user differentiate multiple uses of the same functions within a particular MCU. Many different evaluation and control trees can be occurring simultaneously within the MCU, because MCU executions are controlled by a real-time multi-tasking executive, proven in numerous installations in our 2350 Series MCUs.

3 DOMAIN CONTROL
PID CONTROL
TIME DELAY (before subsequent operation)
EXTRACT DATE/TIME IN SECONDS
CONDITIONAL SUBTREE OPERATION

PEER-TO-PEER CONTROL FUNCTIONS

All Geomation MCUs & NRUs can communicate directly with each other, without control or arbitration by a "host" computer. TELL, LISTEN and GET are functions available for user programming, to generate messages sent from an originating node, and specify the resultant actions that occur at a destination node. Like all messages, PEER-TO-PEER messages can be repeated through intervening nodes (user programmable message routing).

TELL (tell value to another network node)
LISTEN (to trigger an evaluation tree when a value is received)
GET (get a new value from another node and proceed with evaluation when value is received)

CONTROL SYSTEMS

CONTROL SYSTEMS refers to complete control applications already implemented by Geomation in the MCU at a lower software level and a higher end-user interface level. Whereas CONTROL FUNCTIONS are linked together and supported by users and 3rd party systems contractors, CONTROL SYSTEMS are complete end applications implemented, documented, and supported by Geomation.

Geomation's development of Control Systems has been evolutionary, driven by market request. Three criteria have prevailed in the decision to develop a Control System: 1) the application was complex or difficult to implement using Control Functions, 2) it would have required an inappropriate (non-industry standard) extension of the Control Functions, which are intended as standard tools, and 3) there appeared to be adequate continuing market potential to justify the development, documentation, and cost of long-term support for the application and its users.

GATE CONTROL (open channel flow control algorithms)
SCANIVALVE CONTROL (multiport pressure multiplexer)
PNEUMATIC MULTIPLEXER SYSTEM (pressure-balance measurements such as gas piezometers or bubbler columns)
AIRBORNE PARTICULATE SAMPLER CONTROL (remote hi-vol samplers)
HYDROLAB "H20" MONITOR (in-situ water quality parameters)

ORDERING INFORMATION

REMOTE SYSTEM UNITS

2370 (MCU) Measurement &
Control Unit
2371 (MCU) Measurement &
Control Unit
2372 (NRU) Network Repeater Unit
2373 (NRU) Network Repeater Unit

INSTRUMENTATION OPTIONS

2370-010 +5 V Excitation Power Supply
2370-011 ± 5 V (or +10 V) Excitation
Power Supply
2370-012 ± 12 V (or +24 V) Excitation
Power Supply
2370-015 Plug-in Relay Pack (Power
Supply Site)
2370-060 Vibrating Wire Converter
2370-061 Status & Control Interface

COMMUNICATION OPTIONS

2370-400 (TNM) Telephone Network
Modem
2370-401 (SIO) 2nd EIA and RAN
Wireline Option
2370-402 (FOL) Fiber Optic Link
2370-403 (SDI) 2nd EIA and SDI-12
Interface Option
2370-420 YAGI Antenna Kit
2370-422 Hi-Gain Omni Antenna Kit

UNIT POWER OPTIONS

AP-7012 30W Power Supply
AP-7013 10AH Uninterruptible Power
System
AP-7015 10 W, 10 AH Solar Power System
AP-7016 20W, 10 AH Solar Power System
AP-7017 14 AH Alkaline Battery Unit

ACCESSORIES

AP-7023 Charger For Spare Rechargeable
Batteries
AP-7024 AC Power Charging Adapter
AP-7025 Replacement 10 AH
Rechargeable Battery Pack
AP-7027 Replacement 14 AH Alkaline
Battery Pack
CD-7001 Network Gateway Cable -
2370 Series
CD-7002 Weatherproof RS-232 Connector
Feed-thru Assembly
CD-7003 PNM Connection Cable
AI-7080 MCU Wall Mounting Bracket
AI-7082 Power Unit Pipe Clamps (2-3/8")
AI-7083 Power Unit Pipe Clamps (3-3/8")
AI-7084 Power Unit Pipe Clamps (4-5/8")
AI-7091 Expanded MCU Housing
AI-7099 Specialized Tool Kit

Geomatics, Inc.
15000 West 6th Avenue
Golden, Colorado 80401 U.S.A.
TEL: (303) 278-2350
FAX: (303) 279-1029

PATENTS

Geomatics System 2300 and
Components: U.S. Patent Nos. 4,695,920;
D300,024; D302,428; D305,091; others
pending.

RIGHTS IN SOFTWARE AND TECHNICAL DATA

GEONET and GEOGRAPH are Program
Property of Geomatics, Inc., which are
licensed for use in conjunction with System
2300 installations. The terms and conditions
relating to program material use are specified
by license agreement provided with the user
documentation. End user acknowledgement
of the terms and conditions of the license
agreement is required as a condition of
Geomatics continuing performance under
the agreement. Use, duplication, or disclo-
sure by the U.S. Government is subject to
restrictions as set forth in subparagraph
(c)(1)(ii) of the Rights in Technical Data
and Computer Software clause DOD FAR
Supp 252.227-7013.

TRADEMARKS

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MS-DOS is a trademark of Microsoft
Corporation

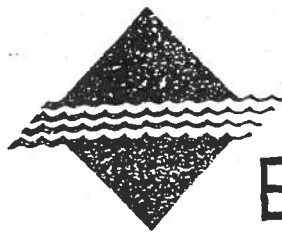
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Printed in U.S.A.

PRESSURE INDICATORS, PI-103, PI-203, PI-303

ISA FORM S20.41a

AIR STRIPPER SPECIFICATIONS, STP-1, STP-2



North East Environmental Products, Inc.

June 7, 1991

Mr. Roy Ambrose
Woodward-Clyde Consultants
Stanford Place 3, Suite 600
4582 South Ulster Street Parkway
Denver, CO 80237

RE: Proposal #69118
Project 91C4524

Dear Mr. Ambrose:

I have selected our Model 31221 ShallowTray aeration system for the groundwater treatment application you sent us an RFQ for on May 29.

I understand that the treatment flow rate is in the range of 20 to 120 gpm and that you intend to use the equipment for a permanent groundwater treatment application. The actual operating flow rate will be 90 gpm. The water temperature is assumed to be 50 F and the other water parameters are as listed in the RFQ.

Expected performance of the ShallowTray aeration system is as follows:

Contaminant	Untreated ppb	After 1st Tray ppb	After 2nd Tray ppb	After 3rd Tray ppb
20 gpm TCE	80,000	120	<1	<1
90 gpm TCE	80,000	401	8	<1
120 gpm TCE	80,000	497	13	<1

The Model 31231 unit as proposed includes the following components:

- Fabricated steel base
- 1 Water holding tank, 304 L ss
- 3 aeration trays, 304 L ss
- Inlet, outlet and internal piping, Sch 80, PVC
- Inlet water spray nozzle
- 1 inlet air blower w/inlet screen and flow control damper, 1800 cfm, @ 14" wc, 10 hp, TEFC motor, 3 phase, 230 volt
- 1 Effluent air mist eliminator
- 1 Blower pressure gage

Inlet water pressure gage
Inlet and outlet sampling ports
Sump tank water level sight gage
Low and high blower air pressure switches, EXP enclosure
High sump water level switch

The overall dimensions of the unit are 7'6" high, 12'8" long and 6'6" wide.
The unit weighs approximately 3600 pounds

The pricing for a Model 31231 unit as described is as follows:

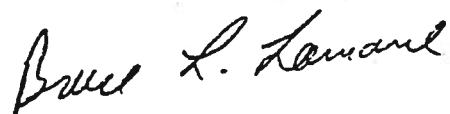
Model 31231 unit as described above -	\$43,750
Two days start-up assistance -	\$500/day plus expenses
Spare parts - Blower motor	\$700
Granular activated carbon system off gas treatment system	
Tigg Nitox N3000	\$11,000 each
Accumulator cabinet	\$2,875 each
Breakthrough indicator	\$100 each

Shipping costs are not included. The equipment can be ready for shipment in 6-10 weeks. Purchase terms are 50% with the order, 50% net 30 days from delivery.

Prices quoted in this proposal are valid for 90 days only.

I look forward to working with you on this project. Once again, thank you for your interest in our products.

Sincerely,



Bruce L. Lamarre,
President

SPECIFICATION DATA SHEET
VENDOR SUPPLIED INFORMATION
AERATION EQUIPMENT

Capacity design flow rate;	1-120 gpm
Type of unit:	ShallowTray aerator
Manufacturer:	North East Environmental Products, Inc.
Number of Trays:	3
Type of stripping media:	N/A
Stripping surface area:	N/A
Influent flow rate and TCE concentration:	20 ppm @ 20 gpm 20 ppm @ 90 gpm 20 ppm @ 120 gpm
Effluent flow rate and TCE concentration:	<5 ppb @ 20 gpm <5 ppb @ 90 gpm <5 ppb @ 120 gpm
Blower type:	Cincinnati Fan PB-15 or PB-15WA, radial wheel
Blower motor specification:	3 phase, 460 volt, TEFC 1.15 service factor
Pump type:	N/A
Pump motor specification:	N/A
List of controls included:	Sump high level switch Blower low air pressure switch Blower high air pressure switch
Mist eliminator specifications:	Koch style 4310, 304 stainless steel, 4" thick, 24" square

Backwash pump specifications:

N/A

Unit dimensions:

The overall dimensions of the unit are 7'6" high, 12'8" long and 6'6" wide

Total weight:

Approximately 3600 lbs.

ABOVE GRADE GROUNDWATER PIPING SPECIFICATIONS

	Woodward-Clyde Engineering Specification	Standard Number G
By: J. D. Porter	Piping Material Specification	Page 1 of 1
Approved: <u>JDP</u>		Issued: 09-13-91
		Revised: _____

Recommended Service: Above grade groundwater transfer and well instrumentation.

<u>Pipe</u>	<u>Description</u>
1/2" thru 1 1/2"	Schedule 80, PVC, Class 12454-B, threaded, in accordance with ASTM D-1784.
2" thru 6"	Schedule 40, PVC, Class 12454-B, plain ends, in accordance with ASTM D-1784.
<u>Valves</u>	
1/2"	Ball, Class 150, PVC, threaded, True Union Ball Valve or equal.
2"	Ball, Class 150, PVC, socket, True Union Ball Valve or equal.
2"	Globe, Class 150, bronze, threaded, Crane Fig. No. 14 1/2P or approved equal.
4", 6"	Butterfly, PVC body, polypropylene seat, EPDM disc, Harrington Part No. BFVPVE-000A or equal.
<u>Fittings</u>	
1/2" thru 1 1/2"	Type 1, Grade 1, PVC, Class 12454-B, Schedule 80, threaded.
2" thru 6"	Type 1, Grade 1, PVC, Class 12454-B, Schedule 40, socket.
<u>Flanges</u>	
2" thru 6"	Type 1, Grade 1, Class 150, flat face, PVC, Schedule 80, socket.
<u>Unions</u>	
1/2" thru 3"	Type 1, Grade 1, PVC, Schedule 80, socket.
<u>Bolts</u>	
All Sizes	Hex head machine bolts, ASTM A307, Grade B with heavy hex nuts.
<u>Gaskets</u>	
All Sizes	1/8" Neoprene, full face, 50-70 durometer A, Class 150.
<u>Cement for Socket</u>	
<u>Joints</u>	Heavy duty industrial grade, Nibco/Chemtrol PVC Solvent cement or approved equal.
<u>Primer</u>	Primer as recommended by the manufacturer of the pipe and pipe fittings.

WELL PUMP RISER PIPING SPECIFICATION

	Woodward-Clyde Engineering Specification	Standard Number D
By: J. D. Porter	Piping Material Specification	Page 1 of 1
Approved: <u>JDP</u>		Issued: 09-13-91
		Revised: _____

Recommended Service: Well pump riser piping.

<u>Pipe</u>	<u>Description</u>
2"	Schedule 40, ASTM A312TP304, electric fusion welded stainless steel, T & C.
<u>Valves</u>	
2"	Ball, brass, screwed, Marpac Fig. No. B780T or approved equal.
<u>Fittings</u>	
2"	ANSI B16.3, Class 300, TP304, stainless steel, screwed.
<u>Unions</u>	
2"	ANSI Class 300, TP304 stainless steel, screwed.
<u>Flanges</u>	
2" and 3"	ANSI B16.5, Class 150 forged stainless steel, ASTM A182 Grade F304, FF, threaded.
<u>Gaskets</u>	
2" and 3"	1/8" Neoprene, full face, 50-70 durometer A, Class 150.
<u>Bolting</u>	
All Sizes	Hex head machine bolts, 304 stainless steel, with heavy hex nuts.

Appendix B

APPENDIX B

DRAWINGS

FOSTER WHEELER ENERGY CORP.
PERRYVILLE OFFICE PARK
CLINTON, NEW JERSEY

SHEET TITLE

- DRAWING NUMBER**


-
- A detailed location map of the site. The map is enclosed in a rectangular border. At the top, a line represents 'CRESTWOOD DRIVE'. In the upper right, a rectangular structure is labeled 'PUMP BUILDING'. To its left, a hatched area represents 'EXISTING RAILROAD TRACKS'. Further left is a small circular structure labeled 'TREATMENT BUILDING'. To the right of the treatment building is a rectangular structure labeled 'EXISTING WCC TRAILER'. A dashed line, representing a proposed or existing path, winds from the railroad tracks, past the treatment building, and then forms a large loop at the bottom of the map. Along this path, several monitoring wells are indicated: 'MW-3' and 'RW-1' are near the railroad tracks; 'MW-11', 'RW-2', and 'RW-3' are at the bottom of the loop. A north arrow is located in the upper left corner, pointing upwards. The title 'LOCATION MAP' is centered at the bottom, with 'N.T.S.' (Not To Scale) written below it.


DWG. NO.		DESCRIPTION		DWG. NO.		DESCRIPTION		REVISIONS		BY		DATE		DISTRIBUTION		DATE		CONTRACT NO.		OWNER NO.		DRAWING NO.		REV. NO.	
REFERENCE DWGS.		REFERENCE DWGS.														07/12/91		91C4534		N/A		01-00-001		<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"> <div style="width: 10px; height: 10px; background-color: black;"></div> </div>	

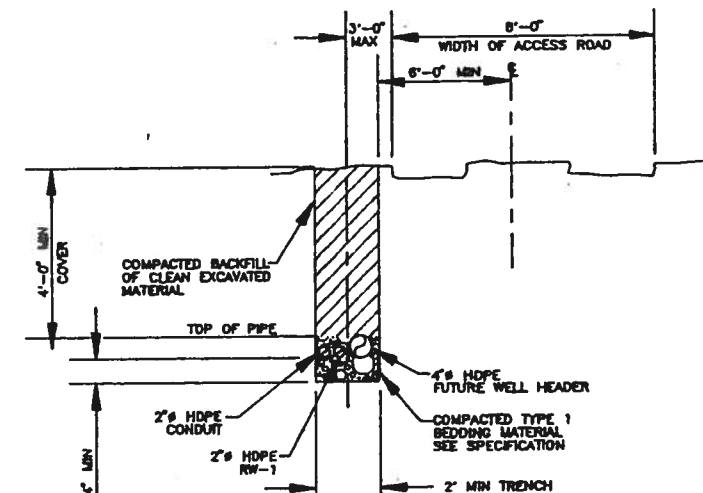
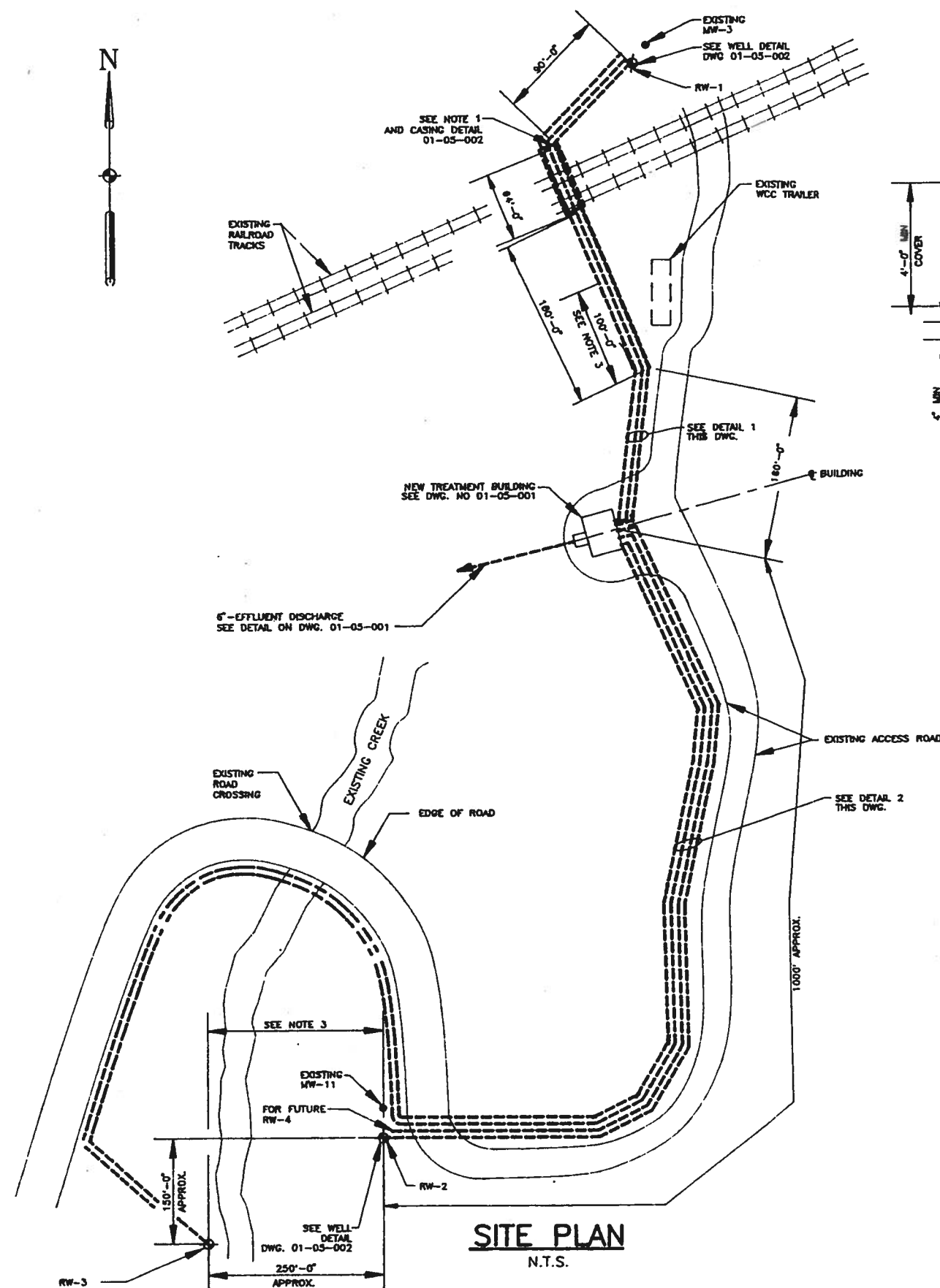
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	THREE-WAY CONTROL VALVE		FLANGE OR CORNER TAP TEST CONNECTIONS WITHOUT ORIFICE PLATE
	FOUR-WAY CONTROL VALVE		RESTRICTIONS ORIFICE
	ANGLE VALVE		PILOT LIGHT
	MOTOR OPERATOR VALVE ACTUATOR		FLOW NOZZLE
	DIAPHRAM ACTUATED CONTROL VALVE		FIELD-MOUNTED DISCRETE INSTRUMENT
	GLOBE CONTROL VALVE		AUXILIARY LOCATION COMPUTER FUNCTION
	DIAPHRAM, SPRING-OPPOSED OR UNSPECIFIED ACTUATOR		FIELD-MOUNTED DISTRIBUTED CONTROL SYSTEM FUNCTION
	BUTTERFLY CONTROL VALVE		DISTRIBUTED CONTROL SYSTEM FUNCTION
	SPRING-OPPOSED ACTUATOR		PRIMARY LOCATION COMPUTER FUNCTION
	VENTURI TUBE		FIELD-MOUNTED COMPUTER FUNCTION
	PRESSURE-REDUCING SELF-ACTUATED REGULATOR		AUXILIARY LOCATION COMPUTER FUNCTION
	SELF-ACTUATED RUPTURE DISK OR SAFETY HEAD FOR VACUUM RELIEF		PURGE OR FLUSHING DEVICE
	SELF-ACTUATED RUPTURE DISK OR SAFETY HEAD FOR VACUUM RELIEF		RESET FOR LATCH-TYPE ACTUATOR
	SELF-ACTUATED BACKPRESSURE REGULATOR, SELF-CONTAINED		UNDEFINED INTERLOCK LOGIC
	SOLENOID VALVE ACTUATOR		HAND ACTUATOR OR HANDWHEEL
	SELF-ACTUATED RESTRICTION ORIFICE DRILLED IN VALVE		DIAPHRAGM SEAL
	SELF-ACTUATED FLOW STRAIGHTENING VANE		UNDEFINED SIGNAL
	SELF-ACTUATED PRESSURE RELIEF OR SAFETY VALVE		PNEUMATIC SIGNAL
	VARIABLE AREA FLOW INDICATOR		SPRING, WEIGHT OR INTEGRAL PLOT

TABLE 1
IDENTIFICATION LETTERS

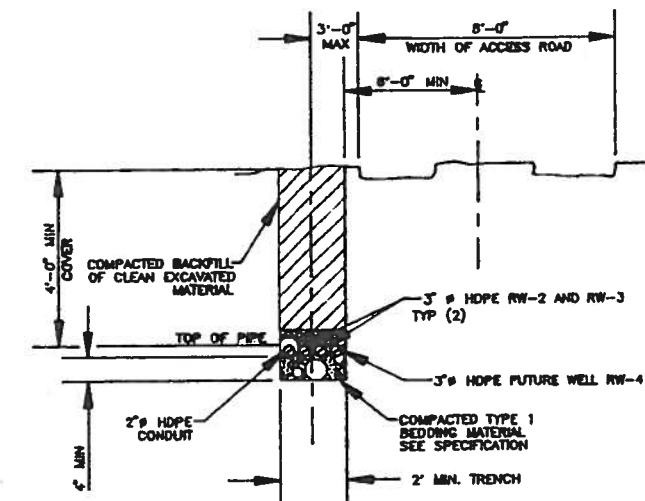
	FIRST LETTER (4)		SUCCEEDING LETTERS (3)		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	Analysis (3,19)		Alarm		
B	Burner, Combustion		User's Choice (1)	User's Choice (1)	User's Choice (1)
C	User's Choice (1)			Control (13)	
D	User's Choice (1)	Differential (4)			
E	Voltage		Sensor (Primary Element)		
F	Flow Rate	Ratio (Fraction) (4)			
G	User's Choice (1)		Glass, Viewing Device (9)		
H	Hand				High (7, 15, 16)
I	Current (Electric)		Indicate (10)		
J	Power	Scan (7)			
K	Time, Time Schedule	Time Rate of Change (4,21)		Control Station (22)	
L	Level		Light (11)		Low (7, 15, 16)
M	User's Choice (1)	Momentary (4)			Middle, Intermediate (7, 15)
N	User's Choice (1)		User's Choice (1)	User's Choice (1)	User's Choice (1)
O	User's Choice (1)		Orifice, Restriction		
P	Pressure, Vacuum		Point (Test) Connection		
Q	Quantity	Integrate, Totalize (4)			
R	Radiation		Record (17)		
S	Speed, Frequency	Safety (8)		Switch (13)	
T	Temperature			Transmit (18)	
U	Multivariable (6)		Multifunction (12)	Multifunction (12)	Multifunction (12)
V	Vibration, Mechanical Analysis (19)			Valve, Damper, Louver (13)	
W	Weight, Force		Well		
X	Unclassified (2)	X Axis	Unclassified (2)	Unclassified (2)	Unclassified (2)
Y	Event, State or Presence (20)	Y Axis		Relay, Compute, Convert (13, 14, 18)	
Z	Position, Dimension	Z Axis		Driver, Actuator, Unclassified Final Control Element	

<p>Woodward-Clyde</p> <p>Consulting Engineers, Geologists and Environmental Scientists</p> <p>201 Westbrook Blvd. Wayne, New Jersey 07470</p>			
<p>CLIENT : FOSTER WHEELER ENERGY CORP.</p>			
<p>LOCATION : MOUNTAINTOP, PA.</p>			
<p>INSTRUMENTATION STANDARDS</p>			
<p>CONTRACT NO.</p> <p>91C4824</p>	<p>OWNER NO.</p> <p>N/A</p>	<p>DISPATCH NO.</p> <p>01-00-002</p>	<p>REV. NO.</p> <p>1</p>

Woodward-Clyde 
Consulting Engineers, Geologists and Environmental Scientists
201 Wilburbrook Blvd.
Wayne, New Jersey 07470



TYPICAL DETAIL 1
N.T.S.



TYPICAL DETAIL 2
N.T.S.

1. HORIZONTAL BORE RAILROAD CROSSING, UNDER BOTH SETS OF RAILROAD TRACKS AS SHOWN
2. H.D.P.E. PIPE AND CONDUIT TO BE BURIED WITH A MINIMUM OF 4" OF COVER ALONG THE EDGE OF THE ROAD AS SHOWN ON THE SITE PLAN.
3. TREE CLEARING WILL BE NECESSARY FOR THIS EXCAVATION AREA, AND ALONG THE EDGE OF THE ROAD WHERE TREES ARE IN THE ROUTE OF THE UNDERGROUND EXCAVATION. CONTRACTOR TO DETERMINE EXTENT OF TREE CLEARING REQUIRED AT THE SITE VISIT.

Woodward-Clyde 
Consulting Engineers, Geologists and Environmental Scientists
301 Wilentz Brook Blvd
Wayne, New Jersey 07470

CLIENT :	FOSTER WHEELER ENERGY CORP.
LOCATION :	MOUNTAIN TOP, PA

**SITE PLAN & DETAILS
INTERIM REMEDIAL DESIGN
FOSTER WHEELER—MOUNTAIN TOP P.A.**

CONTRACT NO.	OWNER NO.	DRAWING NO.	REV. NO.
8104834	N/A	01-02-001	1

[illegible]

02-103
PLOT 1=1 102 02/14/91



1. WORK THIS DRAWING WITH P & I.D.
01-04-002
2. FOR BILL OF MATERIAL & DETAILS
SEE DRAWING NO. 01-04-008
3. ALL VALVES SHALL BE LINE SIZE
UNLESS STATED OTHERWISE

GROUNDWATER RECOVERY WELL

SIZE: 8" DIAMETER CASING
DEPTH: 125 FT. (5 FT. SUMP INCLD.)
SCREENED INTERNAL: 60 THRU 120
MAT'L SCREEN: 304 ST. STL
MAT'L CASING: 304 ST. STL

GROUNDWATER RECOVERY WELL

SIZE: 8" DIAMETER CASING
DEPTH: 105 FT. (5 FT. BUMP INCLD.)
SCREENED INTERNAL: 40 THRU 100
MAT'L SCREEN: 304 ST. STL
MAT'L CASING: 304 ST. STL

GROUNDWATER RECOVERY WELL

SIZE: 8" DIAMETER CASING
DEPTH: 105 FT. (3 FT. SUMP INCLD.)
SCREENED INTERNAL: 40 THRU 100
MAT'L SCREEN: 304 ST. STL
MAT'L CASING: 304 ST. STL

FUTURE WELL

FUTURE WELLS

GROUNDWATER RECOVERY PUMP

TYPE: SUBMERSIBLE, MULTI-STAGE
FLOW RATE: 10/40 G.P.M.
HEAD: 150 T.D.H.
MATERIAL: 304 S.S.
DRIVER: 3 H.P. 3500 R.P.M.
480/3/60

GROUNDWATER RECOVERY PUMP

TYPE: SUBMERSIBLE, MULTI-STAGE
FLOW RATE: 10/50 C.P.M.
HEAD: 150 T.O.H.
MATERIAL: 304 S.S.
DRIVER: 3 H.P. 3500 R.P.M.
480/3/60

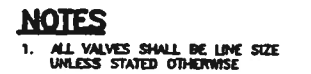
GROUNDWATER RECOVERY PUMP

TYPE: SUBMERSIBLE, MULTI-STAGE
FLOW RATE: 80/75 G.P.M.
HEAD: 150 T.O.H.
MATERIAL: 304 S.S.
DRIVER: 5 H.P. 3500 R.P.M.
480/3/80

[illegible]

STEP-1
GROUNDWATER STRIPPER
TYPE: SHALLOW TRAY
DESIGN FLOW RATE: 20-120 G.P.
DESIGN INFLUENT: 20,000 P.P.B.
DESIGN EFFLUENT: 5 P.P.B.
SIZE: 3-PASS UNIT

SIP-2
GROUNDWATER STRIPPER
TYPE: SHALLOW TRAY
DESIGN FLOW RATE: 20-120 G.P.M.
DESIGN INFLUENT: 20,000 P.P.B.
DESIGN EFFLUENT: 5 P.P.B.
SIZE: 3-PASS UNIT



BL-1
STRIPPER AIR BLOWER
TYPE: CENTRIFUGAL
FLOW RATE: 1800 SCFM
HEAD: 14" W.C.
MATERIAL:
DRIVER: 10 H.P. 3500 R.P.M.
480/3/80

BL-2
STRIPPER AIR BLOWER
TYPE: CENTRIFUGAL
FLOW RATE: 1800 SCFM
HEAD: 14" W.C.
MATERIAL:
DRIVER: 10 H.P. 3500 R.P.M.
480/3 /80

[illegible]



1. BUILDING HEIGHT WILL BE 8'-0" TO EAVE, WITH A SHALLOW PITCH ROOF. RIDGE WILL RUN LONGITUDINALLY NORTH/SOUTH.

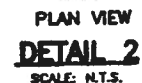
DWG. NO.	DESCRIPTION	DWG. NO.	DESCRIPTION	REVISIONS	BY	DATE	REVISIONS	BY	DATE	DISTRIBUTION	DATE	SCALE	CUSTOMER
												1/2" = 10'	FOSTER WHEELER ENERGY CORP.
													LOCATION : MOUNTAIN TOP, PA.
													TREATMENT BUILDING GENERAL ARRANGEMENT
													CONTRACT NO. 91C-0826
													OWNER NO. N/A
													DRAWING NO. 01-CG-001
													REV. NO.

00-1078
PLAT 101 107
00/13/91



NOTES

- SECTION A-A**
SCALE: N.T.S.
TYPICAL CROSS SECTION
SHOWING CASING

[illegible]

Appendix C

**OPERATIONS AND
MAINTENANCE MANUAL**

TABLE OF CONTENTS

**FOSTER WHEELER ENERGY CORPORATION
GROUNDWATER REMEDIAL FACILITY
MOUNTAINTOP, PENNSYLVANIA
OPERATIONS AND MAINTENANCE MANUAL**

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 - 1.2 OBJECTIVE**
- 2.0 PHYSICAL FACILITY**
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 - 2.4 GROUNDWATER TREATMENT SYSTEM**
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 - 2.4.2 Operating Procedures/Operator Checks**
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 - 6.1 DISCHARGE MONITORING - SAMPLING, ANALYSIS AND REPORTING
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 - 6.3 AQUIFER CLEAN-UP MONITORING-WELL SAMPLING AND ANALYSIS
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 - 7.1 OPERATIONAL REPORTS - DMR AND PROGRESS REPORT